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OF THE

NEW JERSEY STATE

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Agricultural Experiment Station

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OF THE

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FOR THE YEAR ENDING OCTOBER 31

1917

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Letter of Transmittal.

To His Excellency, Walter E. Edge, Governor of the State of New Jersey:

SIR—I have the honor to submit herewith the Thirty-eighth Annual Report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10, 1880, and which is chapter 106 of the laws of that year.

JAMES NEILSON,
President.

NEW BRUNSWICK, N. J., November 30, 1917.

To His Excellency, Walter E. Edge, Governor of the State of New Jersey:

SIR—In compliance with an act of Congress, approved March 2, 1887, and with an act of the Legislature of this State approved March 5, 1888, I beg leave to submit, on behalf of the Trustees of Rutgers College in New Jersey, maintaining Rutgers Scientific School, the New Jersey State College, for the benefit of Agriculture and Mechanic Arts, the Thirtieth Annual Report of the operations of the department of the College which has been organized in accordance with said act of Congress, and is known as "The State Agricultural College Experiment Station."

W. H. S. DEMAREST,
President.

NEW BRUNSWICK, N. J., November 30, 1917.

Treasurer's Report

Irving E. Quackenboss, in account with the New Jersey State *Agricultural Experiment Station, November 1, 1916, to October 31, 1917.*

Appropriation for Salaries and Expenses

Appropriation	$29,000.00
Collections for Sales of Milk, Cream, and Dairy Stock, Glassware Tested, and Milk Testers' Licenses Issued	10,908.14
Collections for Sales of Swine	6,211.44
Collections for Sales of Peaches	2,082.08
Total	$48,201.66

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	$21,135.40
Bills submitted to State Comptroller for direct payment	
Advertising	75.00
Books and Magazines	38.95
Chemical Supplies	186.28
Coal	1,308.12
Electric Current	764.83
Express, Freight, and Cartage	491.08
Extra Hour and Day Labor	1,749.44
Farm Machinery and Tools	1,280.22
Feed and Shavings	11,485.57
Fertilizers	1,665.90
Gas	200.03
Gasoline and Oil	57.80
Live Stock	25.00
Hog Cholera Serum	190.04
Office Furniture	46.75
Office Supplies	360.24
Photographic Supplies and Blue Prints	122.41
Postage	1,372.67
Printing and Stationery	1,365.65
Registration of Animals	7.25
Repairs	783.21
Scientific Apparatus	29.76
Team Hire	108.00
Telephone	633.85
Telegraph	114.40
Traveling Expenses—Managers	210.61
Traveling Expenses—Officers	937.32
Traveling Expenses—Sampling Feeds and Fertilizers	386.12
Trees, Seeds, and Vines	154.36
Veterinary Services	100.00
Water and Ice	99.01
Sundries	124.12
	$47,609.39
Amount reserved by requisition until next fiscal year	309.87
Amount reverting to State Treasury	282.40
Total	$48,201.66

Appropriation for Printing Bulletins

Appropriation	$7,000.00

PAYMENTS

Bills submitted to State Comptroller for direct payment for Printing Bulletins	5,391.03
Amount reserved by requisition until next fiscal year	1,607.93
Amount reverting to State Treasury	1.04
Total	$7,000.00

Appropriation for the Purpose of Carrying into Effect "An Act to Provide for Locating and Abolishing Mosquito-Breeding Salt Marsh Areas within the State, for Assistance in Dealing with Certain Inland Breeding Places, and Appropriating Money to Carry its Provisions into Effect."

Appropriation	$10,000.00

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	3,135.00
Bills submitted to State Comptroller for direct payment	
Advertising	32.37
Extra Hour and Day Labor	147.20
Mosquito Field Work—Ditching	4,900.00
Photographic Supplies and Blue Prints	78.25
Postage	65.00
Scientific Apparatus	218.74
Telephone	30.25
Traveling Expenses—Officers	1,300.30
Sundries	10.70
	$9,917.81
Amount reverting to State Treasury	82.19
Total	$10,000.00

Appropriation for the Scientific Investigation of Oyster Propagation

Appropriation	$900.00

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	565.00
Bills submitted to State Comptroller for direct payment	
Insurance	28.71
Oyster Laboratory Equipment	191.95
Repairs to Oyster Laboratory Equipment	30.10
Scientific Apparatus	18.60
Storage of Boats	40.00
Traveling Expenses—Officers	23.78
Sundries	.68
	$898.82
Amount reverting to State Treasury	1.18
Total	$900.00

Appropriation for the Maintenance and Operation of the Department of Poultry Husbandry

Appropriation	$7,000.00
Collections for Sales of Poultry and Eggs	5,677.75
Total	$12,677.75

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	7,283.34
Bills submitted to State Comptroller for direct payment	
Books and Magazines	15.00
Chemical Supplies	56.90
Coal	508.20
Extra Hour and Day Labor	190.00
Office Furniture	124.65
Office Supplies	121.38
Oil	12.75
Photographic Supplies and Blue Prints	14.18
Poultry Feed	3,235.90
Poultry Stock	66.00
Poultry Supplies and Tools	305.40
Printing and Stationery	115.50
Repairs	122.08
Scientific Apparatus	13.78
Seeds	19.50
Traveling Expenses—Officers	385.62
Sundries	72.54
	$12,662.72
Amount reserved by requisition until next fiscal year	10.00
Amount reverting to State Treasury	5.03
Total	$12,677.75

Appropriation for Carrying out the Provisions of "An Act Concerning Seeds"

Appropriation	$4,000.00

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	2,846.67
Bills submitted to State Comptroller for direct payment	
Chemical Supplies	35.00
Extra Hour and Day Labor	43.00
Office Furniture	87.44
Office Supplies	39.94
Printing and Stationery	9.00
Repairs	21.37
Scientific Apparatus	713.90
Traveling Expenses—Officers	191.01
Sundries	5.10
	$3,992.43
Amount reverting to State Treasury	7.57
Total	$4,000.00

Appropriation for the Purpose of Maintaining and Carrying on Experimental Work in Floriculture

Appropriation	$3,000.00
Collections for Sales of Flowers	1,922.78
Total	$4,922.78

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	$2,327.50
Bills submitted to State Comptroller for direct payment	
Chemical Supplies	1.75
Coal	1,727.99
Extra Hour and Day Labor	355.66
Fertilizers	45.00
Floriculture Supplies and Tools	95.76
Photographic Supplies and Blue Prints	18.70
Repairs	167.95
Trees, Seeds, and Vines	173.91
Sundries	5.33
	$4,919.55
Amount reverting to State Treasury	3.23
Total	$4,922.78

Appropriation for Carrying Out the Provisions of "An Act to Regulate the Sale of Insecticides"

Appropriation	$1,000.00

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	250.00
Bills submitted to State Comptroller for direct payment	
Chemical Supplies	469.86
Scientific Apparatus	248.92
Sundries	3.33
	$972.11
Amount reverting to State Treasury	27.89
Total	$1,000.00

Appropriation for Buildings, Fences, Equipment in the Department of Poultry Husbandry

Appropriation	$5,000.00

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	1,445.00
Bills submitted to State Comptroller for direct payment	
Buildings, Fences, and Equipment	3,471.83
Extra Day Labor	54.00
	$4,970.83
Amount reserved by requisition until next fiscal year	15.68
Amount reverting to State Treasury	13.49
Total	$5,000.00

Appropriation for Farm Demonstration in Agriculture

Appropriation	$25,000.00

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	19,783.36
Bills submitted to State Comptroller for direct payment	
Chemical Supplies	2.25
Extra Hour and Day Labor	156.60
Farm Machinery and Tools	55.52
Feed	53.92
Fertilizers	22.00
Office Furniture	48.50
Office Supplies	119.53
Photographic Supplies and Blue Prints	18.85
Postage	430.24
Printing and Stationery	516.75
Repairs	40.00
Scientific Apparatus	531.83
Telephone	320.20
Telegraph	36.79
Traveling Expenses—Officers	2,661.30
Trees, Seeds, and Vines	94.44
Sundries	14.33
	$24,906.41
Amount reverting to State Treasury	93.59
Total	$25,000.00

Appropriation for Cranberry Investigation

Appropriation	$1,500.00

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	1,150.00
Bills submitted to State Comptroller for direct payment	
Scientific Apparatus	244.95
Traveling Expenses—Officers	89.28
	$1,484.23
Amount reverting to State Treasury	15.77
Total	$1,500.00

Appropriation for the Maintenance of a Branch Experiment Station

Appropriation	$3,500.00

Note—As the land for the branch Experiment Station was not purchased, there were no charges against this account, the entire appropriation reverting to the State Treasury.

Appropriation for the Purchase of Specimen Types of Meat Animals

Appropriation	$2,000.00

PAYMENTS

Bills submitted to State Comptroller for direct payment for Specimen Types of Meat Animals	1,998.50
Amount reverting to State Treasury	1.50
Total	$2,000.00

Appropriation for Egg-Laying and Breeding Tests

Appropriation	$3,000.00

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	$3,000.00

Feed Inspection Fees Account

Appropriation—Collection of Feed Inspection Fees	$19,077.77

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	9,586.52
Bills submitted to State Comptroller for direct payment	
Books and Magazines	164.63
Chemical Supplies	118.68
Electric Current	225.24
Express, Freight, and Cartage	227.69
Extra Hour and Day Labor	515.88
Farm Machinery and Tools	815.86
Feed and Shavings	4,895.69
Fertilizers	10.05
Gas	59.14
Hog Cholera Serum	63.49
Insurance	25.00
Live Stock	550.00
Office Furniture	106.75
Peach Crates	615.00
Printing and Stationery	5.00
Registration of Animals	28.75
Repairs	18.00
Scientific Apparatus	117.66
Team Hire	36.00
Telephone	225.62
Telegraph	24.37
Trees, Seeds, and Vines	374.44
Water	87.47
Veterinary Services	78.25
Sundries	11.84
	$18,987.02
Amount reverting to State Treasury	90.75
Total	$19,077.77

Fertilizer Inspection Fees Account

Appropriation—Collection of Fertilizer Inspection Fees...... $23,325.63

PAYMENTS

By Treasurer of the Experiment Station	
Salaries and Wages	$13,713.58
Bills submitted to State Comptroller for direct payment	
Chemical Supplies	212.39
Electric Current	429.92
Express, Freight, and Cartage	277.99
Extra Hour and Day Labor	235.64
Farm Machinery and Tools	309.74
Feed and Shavings	4,441.23
Fertilizers	251.75
Gas	78.54
Hog Cholera Serum	46.60
Ice	8.08
Office Furniture	10.80
Office Supplies	5.58
Photographic Supplies and Blue Prints	15.08
Postage	24.34
Repairs	171.62
Scientific Apparatus	159.63
Team Hire	72.00
Telephone	479.24
Telegraph	89.01
Traveling Expenses—Managers	53.20
Traveling Expenses—Officers	1,223.16
Traveling Expenses—Sampling Fertilizers	865.39
Trees, Seeds, and Vines	28.09
Veterinary Services	50.25
Sundries	38.56
	$23,291.41
Amount reserved by requisition until next fiscal year	5.80
Amount reverting to State Treasury	28.42
Total	$23,325.63
Total Appropriations	$101,900.00
Total Collections	69,205.59
Total of all Appropriations and Collections	$171,105.59

Summary of Analysis of all Expenditures

Advertising	107.37
Books and Magazines	218.58
Buildings, Fences, Equipment—Poultry Department	3,471.83
Chemical Supplies	1,083.11
Coal	3,544.31
Electric Current	1,419.99
Express, Freight and Cartage	996.76
Extra Hour and Day Labor	3,447.42
Farm Machinery and Tools	2,862.50
Feed and Shavings	24,112.31

Fertilizers	1,994.70
Gas	337.71
Gasoline and Oil	70.55
Hog Cholera Serum	300.13
Insurance	53.71
Live Stock	2,639.50
Mosquito Field Work—Ditching	4,900.00
Office Furniture	424.89
Office Supplies	646.67
Peach Crates	615.00
Photographic Supplies and Blue Prints	267.47
Postage	1,892.25
Printing Bulletins	5,391.03
Registration of Animals	36.00
Repairs	1,354.33
Salaries and Wages	86,221.37
Scientific Apparatus	2,489.72
Small Printing and Stationery	2,011.90
Team Hire	216.00
Telephone	1,689.16
Telegraph	264.57
Traveling Expenses—Managers	263.81
Traveling Expenses—Officers	6,811.77
Traveling Expenses—Sampling Feeds and Fertilizers	1,251.51
Trees, Seeds, and Vines	844.74
Veterinary Services	228.50
Water and Ice	194.56
Sundries	326.53
	$165,002.26
Amount reserved by requisition until next fiscal year	1,949.28
Amount reverting to State Treasury	
Maintenance of Branch Station Appropriation	3,500.00
Unused Requisitions	654.05
Total	$171,105.59

Collections Account.

RECEIPTS

From Poultry Department	
Collections for Sales of Poultry and Eggs	$5,677.75
From Floriculture Department	
Collections for Sales of Flowers	1,922.78
From Horticulture Department	
Collections for Sales of Peaches	2,082.08
From Dairy Department	
Collections for Sales of Milk, Cream, and Dairy Stock, Glassware Tested, and Milk Testers' Licenses Issued	10,908.14
From Swine Department	
Collections for Sales of Swine	6,211.44
From Chemical Department	
Collection of Fertilizer Inspection Fees	23,325.63
From Chemical Department	
Collection of Feed Inspection Fees	19,077.77
Total	$69,205.59

PAYMENTS

To State Treasurer Collections for Sales of Poultry and Eggs	$5,677.75
To State Treasurer Collections for Sales of Flowers	1,922.78
To State Treasurer Collections for Sales of Peaches	2,082.08
To State Treasurer Collections for Sales of Milk, Cream, and Dairy Stock, Glassware Tested, and Milk Testers' Licenses Issued	10,908.14
To State Treasurer Collections for Sales of Swine	6,211.44
To State Treasurer Collections of Fertilizer Inspection Fees	23,325.63
To State Treasurer Collection of Feed Inspection Fees	19,077.77
Total	$69,205.59

The Auditing Committee of the Experiment Station has examined the accounts of the Treasurer of said Station, and has found them correct.

(Signed) JAMES NEILSON,
JACOB G. LIPMAN,
Auditing Committee.

Financial Statement

New Jersey State Agricultural College Experiment Station
in Account with
The United States Appropriations, 1916-1917.

Dr.

	Abstract	Hatch Fund	Adams Fund
To Receipts from the Treasurer of the United States as per appropriations for fiscal year ended June 30, 1917, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)		$15,000.00	$15,000.00
Cr.			
By Salaries	1	$10,098.82	$11,930.01
Labor	2	981.12	637.76
Publications	3	364.40	....
Postage and stationery	4	556.16	35.70
Freight and express	5	15.40	5.51
Heat, light, water, and power.....	6	242.50	252.83
Chemicals and laboratory supplies..	7	433.25	782.44
Seeds, plants, and sundry supplies.	8	312.81	161.03
Fertilizers	9	8.68	85.50
Feeding stuffs	10	....	360.00
Library	11	20.03	....
Tools, machinery, and appliances..	12	107.60	82.88
Furniture and fixtures............	13	77.70	135.49
Scientific apparatus and specimens.	14	35.98	142.51
Live stock	15	....	....
Traveling expenses	16	999.84	....
Contingent expenses	17	40.14	....
Buildings and land...............	18	705.57	388.34
		$15,000.00	$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the New Jersey State Agricultural College Experiment Station for the fiscal year ended June 30, 1917; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was $....... on the Hatch Fund and $....... on the Adams Fund; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the act of Congress of March 2d, 1887, and $15,000.00 under the act of Congress of March 16th, 1906, and the corresponding disbursements $15,000.00 and $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving balances of $....... and $.......

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2d, 1887, and March 16th, 1906, and in accordance with the terms of said acts, respectively.

(Signed) W. H. S. DEMAREST,
J. G. LIPMAN,
Auditors.

REPORT OF THE DIRECTOR

Report of the Director

JACOB G. LIPMAN, PH.D., *Director.*

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Report of the Director

JACOB G. LIPMAN

Extraordinary conditions now prevailing in the national life are affecting the production and distribution of food in New Jersey. On the one hand, production is encouraged by the rising prices of food-stuffs, and on the other hand it is discouraged by scarcity of labor and high cost of raw materials needed in agricultural production. At best, New Jersey is not self-supporting as to food production. The farmers of the state are now producing an adequate supply of potatoes, vegetables and milk. In fact, the quantities of these food-stuffs are large enough to allow the export of the surplus to neighboring states. Unfortunately, however, the breadstuffs grown in the state fall far short of the normal requirements and this is true even in a more pronounced degree of the meat and meat products.

FACTORS AFFECTING PRODUCTION

In analyzing the factors which play a part in the production of food-stuffs, we find that labor, fertilizer, seed, implements, insect enemies and plant diseases all play a more or less important part. The problem of farm labor is a particularly difficult one to solve at this time. Immigrant labor, formerly an important source of supply for the farmers of New Jersey, is no longer available. The remarkable expansion of industrial enterprises along the seaboard has made serious inroads into the labor resources of the farmer. High wages and shorter hours of employment have created industrial conditions with which the farmer cannot successfully compete. The call to service has prompted many of the young men of the farms of the state to join the military forces of the Nation. Such conditions would naturally tend to limit production in spite of the upward trend of commodities. As a result, there is much land in the state that is not being tilled, even though this is potentially capable of growing good crops. The acreage of land temporarily abandoned has increased to a marked extent, even though economic conditions and the spirit of patriotism are drawing many farmers to exact more from their land.

The supply of commercial fertilizer has been modified both in quality and quantity. No satisfactory substitute has been found for the potash salts formerly imported from Germany. The lack of available potash is making itself felt on the lighter soils of the state, especially in the production of potatoes. Also, in the case of nitrogenous fertilizer there has been a shrinkage in the supply and a striking increase in cost. Organic ammoniates, like tankage, fish, dried blood and cottonseed meal, have nearly doubled in price. Nitrate of soda, available in normal times at $45 to $50 a ton, is selling at about $100 a ton. Sulfate of ammonia, obtainable a few years ago at $65 a ton, cannot now be purchased at $130 or even $140 a ton. Since readily-available nitrogenous fertilizers are essential for intensive production, it is obvious that every effort should be made to place at the disposal of the farmer sufficient supplies of such fertilizers, in order that increased production per acre might, to some extent at least, offset the decrease in the area of cultivated land. Like nitrogenous fertilizers, those containing phosphoric acid are an important factor in crop growth. The source of phosphoric acid is found in the mineral phosphates of Florida and Tennessee, as well as in animal bones. To make these fertilizers more readily accessible to growing crops, sulfuric acid is employed in fertilizer factories. It is estimated that an equivalent of two million tons of sulfuric acid is employed in the manufacture of commercial fertilizers. The cost of this enormous quantity of sulphuric acid most naturally plays a part in determining the cost of phosphoric acid in fertilizers. It is well known that the demand for sulfuric acid in the manufacture of explosives has steadily driven its price to higher levels. All told, therefore, the supply of nitrogen and phosphoric acid has decreased on account of competition for raw materials from other industries, and the cost has increased for the same reason. To make matters worse, much of the shipping, formerly available to the fertilizer trade, is now needed for the carrying of other commodities, and the railroads of the country must, therefore, assume the heavy burden of transporting the large quantities of commercial fertilizers. Delays and higher freight charges are the inevitable outcome of such abnormal conditions.

Information at hand seems to indicate that the supply of agricultural seeds is far from satisfactory as to quantity, and possibly also in quality. Much of the seed used by vegetable growers in the

United States was formerly imported from abroad. Such importations having been discontinued, the growers must depend on home supplies. It is essential for this reason that farmers in New Jersey familiarize themselves with existing conditions in the seed trade and order their supplies of seeds without further delay. Wherever necessary, the types of cropping may be rearranged on the basis of information on seed supplies now obtainable. Incidentally, the growers should look ahead and should attempt to grow for future consumption the seed that may be needed in the state.

The abnormal conditions in manufacturing and transportation make it essential that the farmers at once determine their needs and that they place their orders for immediate delivery. If this is not done, farmers will, in many instances, fail to be properly equipped during the growing season. It would be well, also, to give consideration to the use of such implements as would allow the economy of farm labor. Labor-saving devices of all sorts should be employed wherever possible. A beginning has already been made in the use of farm tractors and of motor cultivators. The use of these appliances should be extended wherever economic conditions may warrant it.

Production of food crops may also be limited through injury caused by injurious insects and plant diseases. In so far as possible, varieties of crops should be grown that are more or less resistant to the attack by fungi. Insecticides and fungicides should be employed and an effort should be made to forecast the appearance and spread of injurious insects and of plant diseases by the employment of scouts who would keep themselves informed on the prevalence and spread of insect and fungous enemies of crops. By paying due heed to the limiting factors in production discussed above, the returns to the farmer may be increased and the net production of foodstuffs materially expanded.

MEANS FOR INCREASING PRODUCTION

Contrary to the impression which prevails among a large number of people in this country, food production calls for much skilled labor. The striking progress which the agriculture of the United States has made within the past generation has been due largely to the adoption of labor-saving machinery, the more extended use of concentrated and available plant-food, and the prevention of serious

injury by insects and fungous diseases. It is obvious that a successful farmer must be well informed on questions related in one way or another to the sciences of physics, chemistry, botany, bacteriology and zoology. But, well informed as is the progressive farmer, the rank and file of farmers in this and other states would gain in efficiency as producers of food-stuffs if given an opportunity to acquire a better training in the theory and practice of agriculture. It is recognized that the establishment and development of vocational schools in the rural districts would lay the foundations for the upbuilding of a large class of highly skilled and well trained young farmers. In other words, efficiency in production may be attained by offering technical training in agriculture to the sons and daughters of farmers and by allowing them to use, thanks to this training, the more complicated types of farm machinery, particularly motor-driven plows and cultivators.

Production may likewise be increased by encouraging a greater degree of cooperation among the farmers. There is no doubt that much time and effort are lost in the hauling of materials to and from town or to and from the nearest freight station. A trip to town is often made at a time when the farmer can ill afford to be away from his fields or his livestock. The loss of two or three hours in the case of one individual may not be a serious matter. On the other hand, when hundreds or thousands of farmers are obliged to use up time for the sake of minor errands in town or for the sake of transporting materials to and from the farm, a condition is created that is far from desirable. It may be proper to suggest that there is room for economy of time and effort through cooperation among the farmers in any given locality. Cooperation may also be depended upon to conserve labor in operations like plowing and fitting for planting, cultivating and the harvesting of crops.

In the season of 1917 there was some effort made to solve the problem of farm labor by the organization of boys' camps as well as of camps of adults. In some localities the boys' camps failed to meet the expectations of the farmers. This was due largely to the fact that school boys from the cities were entirely unfamiliar with farm work and unused to the environment of the rural communities. The farmer has not the time during the growing season—when he himself is working under great pressure—to train boys or men to do ordinary types of farm work. Hence, it would be well

not to expect too much from high school boys or adults that have had no farm experience. Nevertheless, careful selection and some preliminary training may allow of the utilization of such labor to the very considerable advantage of the farmers in New Jersey. Full credit should be given to the Department of Labor of the State for the service which it rendered in securing men for farm work. The Department was, however, confronted with the serious difficulty of finding men with farm experience and at a time when the rate of wages in the city industries were exceptionally high. It is safe to forecast that the labor problem of 1918 will be much more difficult than was that of 1917. Indeed, there is every indication that farmers in the state will reduce their acreage of cultivated land on account of their inability to secure an adequate supply of farm help. If the problem is to be at all solved successfully, resort must be had to legislation which will provide such industrial reorganization as will produce a more adequate supply of farm help.

It has been said, and justly, that fertilizers are, in a sense, substitutes for labor. Liberal fertilization will increase the average yield per acre. Hence, when the supply of farm labor is insufficient, shrinkage in production may be counteracted in some measure by increasing the yields per acre through proper systems of fertilization. It is understood, of course, that any system of fertilization that may be adopted should not decrease the profits which the farmer may expect under avarage conditions. In New Jersey nitrogen and phosphorus are often the limiting factors in production. In the case of the potato crop, the yields may be decreased for lack of available potash in the soil. It appears that certain of the nitrogenous fertilizers, particularly sulfate of ammonia, nitrate of soda and cyanamid, formerly used in agriculture, will be drawn upon primarily to meet the needs of our army and navy. Hence it will be necessary to conserve the nitrogen supply set aside for agricultural uses and to increase in every practical way the home resource of nitrogen, as well as of phosphorus and potassium. Enormous quantities of plant-food contained in weeds, corn stalks, straw, bog hay, sedge grass, etc., are wasted in this state. Under the existing emergency conditions, it should be urged that the farmers of New Jersey resort to composting and that, by means of the compost heap, they make available large quantities of plant-food. By doing this, they will help

to solve the transportation problem and will reduce the cost of producing their crops. By mixing these waste materials, as well as peat and muck, with manure, there can be produced a low-grade but very efficient fertilizer. It may be stated safely that the farmers of our state could easily save $1,000,000 per annum by the using of composts. This would represent only a part of the gain, for the use of composts would inevitably lead to a more permanent improvement in the texture and water-holding power of the soil.

The well-to-do farmers are able to borrow the funds needed by them from the local banks. On the other hand, there are tenant farmers, gardeners or owners of small holdings, who have insufficient working capital and whose borrowing capacity is very limited. These men would become more efficient producers and would increase the acreage of cultivated land if given an opportunity to secure the necessary credit for the purchase of seeds, fertilizers, implements and insecticides. The bankers of the state are beginning to recognize the need for improving the credit facilities of farmers of this type. Nevertheless, it would be well to make a systematic effort toward improving the borrowing facilities of the gardeners and tenant farmers.

Expanded production may be still further encouraged by the cooperative buying of raw materials needed in agricultural production. It is admitted, by both farmers and railroad officials, that commodities bought in carload lots can be transported to best advantage, both as to time and as to freight costs. The farmers' exchanges in New Jersey have done much toward solving this particular problem. There are portions of the state, however, where farmers are not sufficiently well organized to allow the best economy in the transportation of seeds, fertilizers, implements and feeding stuffs. Cooperation should assure the more prompt delivery of these materials and should eliminate and discourage experiences that fell to the lot of many farmers in the spring of 1917. There were numerous complaints at that time to the effect that farmers were obliged to plant their crops without fertilizer, since these had failed to arrive in time.

It would not be amiss to call attention to the fact that New Jersey should be less dependent than it is at present on outside supplies of meat. It is not to be expected that it would be economically desirable to develop livestock farming in New Jersey at the expense of more remunerative types of farming now carried on

in the state. It is true, nevertheless, that the keeping of a few hogs or of one or two beef steers on the average farm is economically feasible and desirable, even though the keeping of a large number of such animals might not be profitable. There is on the average farm more or less waste material in the form of cull vegetables, potatoes, fruit, or of soft corn and partly spoiled grain that should be utilized as animal food. If the average farmer in the state should rigidly use such by-products as animal food, the aggregate in meat production would be very materially increased.

It is also true that at prices now prevailing there is ample encouragement for the expanding of the acreage under wheat and rye. Moreover, these cereals should be milled in the state, so that our population would be less dependent on producers in other states, and on our transportation systems. The by-products of milling would at the same time be available as livestock foods.

FOOD CONSERVATION

Through the home economics division of the extension service of the Station and College, substantial progress has been made in the state in behalf of food conservation. Members of our home economics staff have held demonstrations before many thousands of people and have discussed the subjects of canning, drying and evaporating, as well as the preparation of meals from foods not until now in general use. Much encouragement has been given to the establishment of girls' canning clubs as well as the organization of community canning enterprises. Such community canning establishments were active in Morris, Somerset and Monmouth counties, through which very large quantities of perishable foods were thus conserved for future use. There is now a widespread interest in the possibilities of evaporating and drying as a means of conserving perishable foods. Investigation on the subject is eminently desirable, as is also a further study of methods of food preparation and food conservation. The construction of a home economics laboratory would be a good investment. A laboratory of this type should be equipped to contain the necessary canning outfits, different types of evaporators, facilities for the preparation of various foods, facilities for refrigeration, and at least one class room where lectures and demonstrations could be given. People in the state who have given serious thought to the subject of food preparation and conserva-

tion feel that the subject should be placed on the same solid foundation as is true of the experimental work in crop and animal production now carried on at the different experiment stations. The average workers in home economics have not at present the necessary facilities for testing out recipes and for studying new methods of food conservation.

In connection with food conservation, consideration should be given to the introduction of such crops as are not now generally grown, but may serve to add to our food resources. It is recognized that beans are among the most desirable meat substitutes. There are many types and varieties of edible beans that should be introduced and studied. Particular attention should be given to the possibilities offered by the soybean as a food crop. In oriental countries soybeans are one of the great food staples. They contain about 40 per cent of protein as against only about 20 per cent of protein in navy or pea-beans, most generally grown in the eastern states and in the Middle West. They also contain 15 to 20 per cent of oil, which may be extracted and used for food or industrial purposes. Soybeans have already met with a favorable reception in the state. Their merits should receive further publicity and every effort should be made to extend the area under this crop. Careful observers feel justified in claiming that this crop should assume the importance in New Jersey and adjoining states that is being assumed in the southern states by velvet beans, peanuts and cowpeas, as well as soybeans. If a suitably equipped home economics laboratory were available, a special experimental project could be organized for the study of foods that may be made from soybeans.

Greater emphasis should also be laid on the introduction of alfalfa and sweet clover into localities where they are not now generally grown. The nitrogen problem is one of the peculiar problems of the state from the standpoint of soil fertility as well as of food production, and the more general cultivation of legumes would help to solve some of the more difficult questions of food production.

EDUCATIONAL AGENCIES

Under the present organization of agricultural education in New Jersey, the Experiment Station shares with the State Agricultural College and the State Department of Public Instruction the responsibility of offering a certain type of training in agriculture. Under

the so-called Farm Demonstration Act of the state, the Experiment Station is cooperating with the State Agricultural College in organizing and maintaining county bureaus in the agricultural communities of the state. The cooperation is really of a three-fold nature, since it involves the counties of the state, the State Agricultural College and the State Experiment Station. The county demonstrator in each case is the joint employee of the two state institutions and of his county. He is responsible for offering practical advice to farmers in his county, for holding demonstrations whose purpose it is to introduce better methods of agricultural practice, and, in a more general way, to organize community effort in behalf of more efficient production. His service is not limited to mere production, but deals also with important social problems of our rural communities. The funds that support the farm demonstration service are, therefore, derived from state appropriations made to the Experiment Station, from federal appropriations made to the State Agricultural College, and from county appropriations made by the freeholders of the counties concerned. The cooperative work thus organized is proving very effective and is evidently meeting with appreciation among the people in the state. More recent legislation by the Federal Government, designated as the Smith-Hughes Act, provides for the establishment of vocational schools. Vocational schools in our rural communities deal, naturally, with the agricultural industry. Cooperation has already been arranged for between the Department of Public Instruction and the State Agricultural College in the carrying out of the provisions of the Smith-Hughes Act. Since, however, the work to be carried on under this act concerns also the farm demonstration activities of the Experiment Station, cooperation and coordination of effort will, no doubt, come to play an important role in the rendering of the desired service to the rural population of New Jersey. It is likely that the instructors in the vocational agricultural schools will coordinate their efforts with those of the county demonstrators of their county, as well as with those of the extension specialists employed by the State Agricultural College. The men and women interested in the welfare of the state and in the development of its material resources may, therefore, look with much gratification on the development of a federal and state system of vocational training that in time will constitute one of the mighty forces in the progress of the state.

RESEARCH ACTIVITIES

The research activities of the Station have suffered to a marked extent on account of the serious disturbance of the organization of the Station brought about by the exigencies of the war. Nearly all of the assistants of draft age have enlisted or have been called to enroll in the military service of the country. More than twenty members of the staff have, for this reason, left the service of the Station. It has not been possible, in all cases, to replace these with older men or to arrange the work so as to allow the uninterrupted study of all research projects of the Station. It has been found necessary to discontinue temporarily the investigation of certain agricultural problems. An effort is being made to concentrate the energies of the Station staff on the study of some of the emergency problems that bear on the successful prosecution of the war.

A method for the preparation of available phosphate has been devised by the director of the Station and, after being patented, has been dedicated to the public. Other experiment stations in the United States have tested the method and have confirmed the results obtained by the New Jersey Station. Under the auspices of the National Research Council, of which the director is a member, cooperative experimental work is being organized. The experiment stations of Texas, Tennessee, Kentucky, North Carolina, Georgia, Illinois, Ohio, Iowa, New York, and Virginia, as well as New Jersey, are to carry out the cooperative experiments with the proposed process. It is probable that other experiment stations, among them those of Wisconsin and Delaware, will participate in this cooperative study.

Studies are being made also on methods of making available the potash in greensand marl, found so extensively distributed in New Jersey. These deposits are so vast as to promise to become an inexhaustible source of potash for consumption in the United States. It is hoped that the studies now being carried on here and elsewhere will lead to the devising of methods and processes that would allow the utilization of the greensand marls of New Jersey as a source of potash in agriculture and the arts and industries. Such methods and processes would add many millions to the wealth of the state.

Among the many other lines of research conducted at the Station, particular mention should be made of the fertilizer experiments

with potatoes; variety studies of soybeans; experiments on soil improvement by means of legumes and other green-manure crops; the fertilization of fruit trees; the control of insects injurious to vegetables, fruit, potatoes and other food crops; the study of tomato production in cooperation with the Joseph Campbell Soup Company; feeding experiments with dairy cows and swine; the control of hog cholera; feeding and breeding experiments with poultry; the introduction of improved varieties of corn and small grains; the development of new types of peaches by crossing and selection, and numerous other problems of immediate or more remote importance.

These and other activities of the Station should receive consideration, not only in connection with the present needs of the state, but in connection also with the wonderful possibilities that lie in the fuller utilization of our agricultural resources. In the not distant future, New Jersey farms will be in great demand at materially enhanced prices. More than a million acres of land still undeveloped will be placed under cultivation, and the very large acreage of salt marsh and fresh-water swamps will, by drainage and diking, add to the agricultural domain of the state. While the present emergency conditions may compel us to lay aside some of the work of the Station, it is to be hoped that we shall remember the post bellum problems that will need solution for the sake of our future prosperity.

THE STATION STAFF

The following changes have been made in the staff during the past year:

Appointments

GRACE M. READ, Computer.
GRACE B. WOBBE, Temporary Stenographer.
MARGARET CONNORS, Stenographer.
ANNA G. CONLON, Stenographer.
JAMES G. RUGH, Temporary Contest Foreman.
GEORGE M. DUNN, Temporary Helper.
ALBERT BERTOLLA, Temporary Helper.
ARTHUR T. AVERIE, Temporary Helper.
DAVID SCHMIDT, Field Assistant in Horticulture.
MIKE GRILIK, Janitor.
JOHN LABAR, Janitor.
MABEL V. HOITT, Stenographer.
WILLIAM B. J. REITZE, Temporary Helper.
WILLIAM SCHIEFERSTEIN, Field Assistant.
CARL WIDMAN, Temporary Helper.
RALSTON R. HANNAS, Temporary Poultry Assistant.
JOHN WIDMAN, Temporary Helper.
H. M. BIEKART, Temporary Florist.

EUGENE W. BATES, Temporary Helper, Vineland Egg-Laying Contest.
J. VINCENT BREAZEALE, Temporary Field Assistant.
ROBERT L. SHARRING-HAUSEN, Field Assistant.
P. C. CAMERON, Laboratory Assistant.
JOSEPH KORANDA, Temporary Helper.
WILLIAM WIDMAN, Temporary Helper.
LOUIS SCHWARTZ, Assistant Chemist.
MARIE A. KLEIN, Temporary Statistician.
THURLOW C. NELSON, Temporary Assistant Biologist.
MOLLIE B. HAMELSKY, Temporary Stenographer.
ROSE V. HAGERTY, Temporary Telephone Operator.
JESSIE FISKE, Temporary Assistant Seed Analyst.
C. S. CLARKSON, Temporary Assistant Chemist.
WILLIAM M. REGAN, Dairy Husbandman.
W. B. COMBS, Assistant Dairy Husbandman.
DAVID A. COLEMAN, Assistant in Cranberry Investigations.
LOUISE TREFFINGER, Temporary Stenographer.
CHARLES MCPHERSON, Temporary Herdsman.
MYRTLE CODY, Temporary Stenographer.
ROBERT F. POOLE, Research Assistant.
The following also were employed in a temporary capacity:
Archer P. Crossley; Joseph N. Rogers; James Morris; Edward R. Matthews; Noyes S. Purrington; D. V. A. Della Volpe; Dudley Cobb; Joseph A. Haddon; Hubert Brennan; Benjamin Masurovsky; Merrill G. Clayton; Robert I. Clark; W. H. W. Komp; Katharine H. Hoe; Eugene Brown; Israel Katz; Eugene E. Beyer; Alexander E. Ferguson; G. Hilton Stone; Frank Della Volpe; Edward Johnstone; Richard Goines; Joseph Schmidt; Joseph R. Neller; Paul S. Race; William Goines.

Resignations

D. JAMES KAY, Assistant Chemist.
LOUIS J. KLEINFELD, Assistant Chemist.
FRANK H. JONES, Night Watchman.
CHARLES STRYKER, Janitor.
JACOB A. CARKHUFF, Helper.
RALPH M. HUBBARD, Field Assistant.
PAUL J. SASSI, Field Assistant.
WILLIAM S. LEWIS, Helper.
FRANK C. WOODRUFF, Helper.
ALBERT BERTOLLI, Temporary Helper.
A. SIDNEY CARROLL, Helper in Dairy Department.
FRANK O. FITTS, Assistant Chemist.
JOHN KISH, Helper in Horticultural Department.
PATRICK KERWIN, Helper.
GEORGE M. DUNN, Helper, Vineland Egg-Laying Contest.
CLIFTON HARDING, Helper.
NEVADA S. EVANS, Assistant Seed Analyst.
KATHRYN L. REED, Stenographer.
WILLIAM J. CARSON, Dairy Husbandman.
L. S. RIFORD, Assistant Dairy Husbandman.
GRACE M. REED, Computer.
THURLOW C. NELSON, Temporary Assistant Biologist.
CHARLES GANSLER, Mailing Clerk.
ROY F. IRVIN, Assistant in Poultry Research.
DAVID A. COLEMAN, Assistant in Cranberry Investigations.
JOSEPH HADLEY, Assistant Herdsman.

HERBERT P. ROOD,, Fertilizer Sampler.
HERMAN J. LEVINE, Assistant in Vegetable Gardening.
DAVID SCHMIDT, Field Assistant.
LOUIS SCHWARTZ, Temporary Assistant Chemist.
LOUIS K. WILKINS, Assistant in Soils.
ORVILLE C. SCHULTZ, Research Assistant.
WEBSTER S. KROUT, Research Assistant.
FIDEL P. SCHLATTER, Assistant in Cranberry Investigations.
F. C. MINKLER, Animal Husbandman.

Transfers

ELMER H. WENE, Poultry Assistant, transferred to take charge of International Egg-Laying Contest.
FRED H. FELTON, Janitor, transferred to position of Night Watchman.
ROLAND E. CURTIS, transferred from Research Assistant to Field and Laboratry Assistant in Soils.

EXTENSION STAFF

Appointments

HELEN E. MINCH, Assistant Girls' Club Leader.
CARRIE M. PIMM, Specialist in Home Economics.
HOWARD F. HUBER, Specialist in Fruit Growing.
WILLIAM B. DURYEE, Specialist in Farm Management
ELLWOOD DOUGLASS, County Superintendent of Farm Demonstration for Monmouth County.
CHARLES H. NISSLEY, Specialist in Market Gardening.
A. M. HULBERT, State Leader in Boys' and Girls' Club Work.
JULIAN F. MILLER, Specialist in Fruit Growing
WILLIAM H. HAMILTON, Assistant State Leader in Farm Demonstration.
H. S. LIPPINCOTT, County Superintendent of Farm Demonstration for Morris County.
FRANK A. CARROLL, County Superintendent of Farm Demonstration for Mercer County.
J. A. STACKHOUSE, County Superintendent of Farm Demonstration for Cape May County.
EUNICE STRAW, Home Demonstration Agent for Monmouth County.
HOWARD F. HUBER. Demonstration Agent for Gloucester County.
LOUIS A. COOLEY, Demonstration Agent for Ocean County.
HAROLD E. WETTYEN, Assistant Demonstration Agent for Cumberland County.
LAURETTA P. JAMES, Home Demonstration Agent for Mercer County.
CAROLYN F. WETZEL, Home Demonstration Agent for Mercer County.
WALTER F. KROEMMELBEIN, Assistant Demonstration Agent for Monmouth County.
HELEN E. MINCH, Specialist in Home Economics.
NELLIE JOHNSON, Assistant Home Demonstration Leader.
M. ETHEL JONES, Home Demonstration Agent.
REGINE PORGES, Home Demonstration Agent for Passaic.
HARRY C. HAINES, Demonstration Agent for Somerset County.
MARGARET H. HARTNETT, Home Demonstration Agent for Paterson.
MABEL A. TALLANT, Home Demonstration Agent for Sussex County.
CHARLES ORCHARD SMITH, Assistant State Club Leader.
M. ETHEL JONES, Assistant State Club Leader.
JOSEPHINE C. CRAMER, Home Demonstration Agent for Middlesex County.

ROBERT D. MALTBY, County Superintendent of Farm Demonstration for Atlantic County.
HERBERT R. COX, Demonstration Agent for Camden County.
HARRIOTT WARE, Home Demonstration Agent.
MARGARET C. HAYES, Home Demonstration Agent for Morris County.
ELWOOD L. CHASE, Demonstration Agent for Gloucester County.
W. A. HOUSTON, Assistant Demonstration Agent for Sussex County.
HAROLD E. WETTYEN, Demonstration Agent for Passaic County.
ALBERT SCHAFFLE, Assistant Demonstration Agent for Atlantic County.
WALTER C. VAIL, Demonstration Agent for Salem County.

Resignations

WILLIAM B. DURYEE, County Superintendent of Farm Demonstration for Monmouth County.
ELLWOOD DOUGLASS, County Superintendent of Farm Demonstration for Atlantic County.
A. M. GOODMAN, County Superintendent of Farm Demonstration for Morris County.
WILLIAM H. MCCALLUM, State Leader in Boys' Club Work.
GEORGE B. THRASHER, County Superintendent of Farm Demonstration for Cape May County.
WILLIAM H. HAMILTON, County Superintendent of Farm Demonstration for Mercer County.
HOWARD F. HUBER, Specialist in Fruit Growing.
HELEN E. MINCH, Assistant Girls' Club Leader.
JULIAN F. MILLER, Specialist in Fruit Growing.
HARRY C. HAINES, Assistant Specialist in Fruit Growing.
WALTER F. KROEMMELBEIN, Assistant Demonstration Agent for Monmouth County.
HOWARD F. HUBER, Demonstration Agent for Gloucester County.
LAWRENCE G. GILLAM, Specialist in Fruit Growing.
FANNIE F. COOPER, Assistant State Club Leader.
CARRIE M. PIMM, Specialist in Home Economics.
ELWOOD L. CHASE, County Superintendent of Farm Demonstration for Passaic County.
HAROLD E. WETTYEN, Assistant Demonstration Agent for Cumberland Cunty.

DEPARTMENT ACTIVITIES

A summary of the activities of the different divisions of the Experiment Station, as prepared by the heads of the several departments, is presented in the following pages.

CHEMISTRY

The service rendered by the chemist and his assistants is confined almost entirely to the analysis of samples of fertilizers, lime, feeding stuffs and insecticides. Aside from the official samples collected in the different localities in the state, chemical examination is made also of miscellaneous materials sent by residents of New Jersey. The scope of the analytical and other work done in the

chemistry division of the Station is indicated in the following paragraphs.

Fertilizers

One thousand six hundred and thirty-eight registrations were received from 124 manufacturers. The registrations received before January 22 were published in Bulletin 304; while the remainder will appear in the second fertilizer bulletin. The fertilizer tonnage reports received during the fiscal year were as follows:

		Tons
November, 1916	Mixed Fertilizers	52,328.81
	Fertilizer Materials	7,069.70
April, 1917	Mixed Fertilizers	86,840.44
	Fertilizer Materials	9,146.80
	Total	155,385.75

The total tonnage reported for the fiscal year immediately preceding was 129,148.65.

Fertilizer Inspections

By the end of September there had been received 1,438 samples. Of this number 948 were to be analyzed before the end of the fiscal year. These samples consisted of the following:

256 Samples of Commercial Fertilizers containing nitrogen, phosphoric acid and potash.
297 Samples of Commercial Fertilizers containing nitrogen and phosphoric acid.
19 Samples of Commercial Fertilizers (Duplicates).
6 Samples of Humus and Manures.
16 Samples of Home Mixtures.
137 Samples of Fertilizer Materials.
47 Samples of Ground Bones.
170 Samples of Sundry Materials.

Agricultural Lime

Thirty-six manufacturers registered 76 brands. There were clolected in the open market 23 samples. The analyses of these will be reported in the second fertilizer bulletin.

Commercial Feeding Stuffs

A detailed account of the feeding-stuff inspection was given in Bulletin 311. This bulletin should be ready for distribution at an early date.

During the year 485 manufacturers and jobbers registered 2,665 brands of feeding stuffs; 1,160 samples were analyzed, and it was found that 32.3 per cent did not satisfy the guarantees given for the content of protein, fat and fiber. The tonnage reports for the year 1916 totaled 235,348 tons, which is an increase of more than 7,000 tons over the tonnage of 1915.

Insecticides

Forty-five manufacturers registered 194 brands of insecticides during the past year. One hundred and five samples were received during the inspection and the results obtained by the chemical examination will be reported in a bulletin to be issued in the near future.

HORTICULTURE

This division has experienced more difficulty than usual in retaining its men and the work has been considerably disturbed by enlistment and by the draft. The death of Mr. D. M. Jobbins, the florist, early in November interfered for a time with the progress of the experimental work in floriculture. In fact, it was greatly handicapped until May and June, when Mr. H. M. Biekart was secured temporarily to take up the work. Much difficulty was also experienced in obtaining satisfactory pickers to gather the peach crop at the Vineland experiment orchard during August and September.

When it became apparent that the declaration of war might disturb the experimental work, plans were made to concentrate upon the more important experiments. The peach pruning experiments in the Vineland orchard, set in 1912, are considered to be one of the most important lines of investigation conducted by the department. The first two season's results have been presented in bulletin form and a circular summarizing the results has been published. Yearly bulletins will be needed for bringing the results up-to-date. These will be published as rapidly as time and funds will permit. The trees in this experiment produced a very heavy crop during the past summer, in fact, the yields varied from about ten to at least sixteen baskets per tree. The plots which were summer-pruned

gave ample demonstration that summer pruning delays the maturing of the fruit. This is contrary to the general statement appearing in many of our horticultural publications that summer pruning checks wood growth. In our peach pruning experiments, summer pruning has encouraged wood growth, as well as late growth, and the results of this season strengthen the evidence that summer pruning does not check growth, but rather encourages it

The fertilizer experiments with peaches at Vineland have now been continued for ten years, and the results will be written up as soon as time permits. This orchard was set in 1907 and 1908, and is now one of the oldest orchards in that section of New Jersey. It is now planned to discontinue the fertilizer experiments in orchard number 1, and by means of modern orchard practice to secure, if possible, profitable commercial yields from all the trees during the next few years.

The dusting of peaches has been a very interesting phase of the control of peach diseases in southern New Jersey, and rather extensive spraying and dusting experiments were conducted during the past season at various places in cooperation with peach growers. This work has been in the direct charge of Prof. A. J. Farley.

For some years past the department has been giving much attention to the packing of peaches in Georgia carriers. This work was continued during 1917 with especial reference to the peach production in Burlington, Gloucester, Camden and Cumberland counties. Peach growers in Burlington County had been in the habit of shipping most of their peaches to the Philadelphia markets in baskets. Since 1916, they have been sending their fruit to the New York and more distant markets. They have, to a great extent, found the Georgia carriers a more desirable package than the basket, hence, especial attention was given to visiting growers in Burlington County that needed instruction in the packing of fruit in carriers. Mention may also be made here of the consideration which is being given to the growing of strawberries and of other small fruits by Prof. A. J. Farley.

The greenhouse experiments include, among others, the plant-breeding studies with carnations by Mr. Chas. H. Connors. A considerable number of seedlings are now producing flowers and among the lot, several purple carnations appeared last year. These

seedlings were developed accidentally in an attempt to secure better scarlet varieties than are now on the market. The experiments with gardenias are now yielding very valuable and interesting data. These will be published from time to time as conditions may permit.

Progress in vegetable growing has been greatly handicapped, since the land devoted to the work is on a neglected farm which will have to be considerably improved before certain work can be started. However, variety and strain tests with beets have been conducted for the past three years, and the crop of 1917 should offer some conclusive data on the subject.

Mention should also be made of the progress of the peach breeding experiment. The department now has about twenty-five hundred peach trees from known crosses planted out in orchard form. Some of these are now in their second season and should produce some fruit next year. When these seedlings come into bearing, they should be of great interest to the peach growers of the state, and it is reasonable to suppose that among this large number there are likely to be some that will be of commercial value. Better commercial varieties of peaches are needed by New Jersey growers and it is hoped that this work will produce several of them.

ANIMAL HUSBANDRY

Experimental work now in progress in this division of the Station lays emphasis on methods and costs in pork production. One of the studies under consideration deals with the economy and value of black strap molasses in the brood sow ration. There were included in this experiment 24 head of brood sows, and these were kept under observation from November until April. The different lots received varying amounts of molasses in connection with the grain ration. Records were kept on the feed eaten, costs of grains and litters farrowed.

In another series of tests, 40 head of fall pigs were fed in part by means of self-feeders from weaning time until a 200-pound average weight was attained. Four different grain mixtures were allowed to the animals in the free-choice self-feeder method. Records were obtained on gains, amounts and proportions of feed eaten, also cost of gains and time necessary for each lot to make a 200-pound average. A similar study was made of the combination of forage crops with the free-choice self-feeder on the one

hand, and with a limited grain ration directly supplied on the other. In each case the results were based on the cost of producing a 200-pound market pig. The records secured include data on the rate of gains, cost of gains and amounts and proportions of the different feeds used. Fifty animals were employed in this experiment.

Another experiment dealt with the production of a 200-pound fall pig housed during the winter in a colony house. In this experiment 7 sows and 38 pigs were used, and the animals were kept until they were ready for market. Studies were likewise made of forage-crop mixtures for summer pasture. These were a continuation of similar studies in 1915 and 1916. From November 1, 1916, to October 10, 1917, the animal husbandry department has disposed of 90 head of pure-bred breeding stock to farmers in the state at reasonable prices.

POULTRY HUSBANDRY

The breeding problems of the department are by far the most important. Those dealing with the inheritance of fecundity have been under way for nearly five years and are developing some very interesting and valuable conclusions; as well as some exceptional birds and strains of birds. Cockerels are being distributed each year throughout the state at nominal cost, to improve egg production in farm flocks.

The pigmentation project which deals with the inheritance of color pattern and pigmentation in hybrids is progressing favorably. Within the past year the reciprocal crossing of Black Hamburgs and White Leghorns was added to the Black Lanshan and White Leghorn cross previously used. Birds in the F3 generation are now on range in considerable numbers, and will no doubt allow successful numerical comparisons this fall. The work on the inheritance of egg shell color has progressed through the first stage of the project; namely, the determination of variation in the color of eggs laid by individual hens during the season. This work has been done with Barred Plymouth Rocks and Light Brahmas. The next stage will consist of the study of these birds to determine the mode of inheritance of egg shell color. A study to determine the sequence of sex in chicks hatched from eggs laid by individual

hens is under way with a possible belief that some definite relation may be found between certain measurable factors and sex. This work has not progressed far enough to warrant any such definite assumption, but will be followed through a number of years until any definite relation is proven or disproven.

The strain test which has been in progress for the past year and embraces 14 distinct strains of the White Leghorn breed of fowls is continuing satisfactorily. At the present time a large number of progeny from each of the first matings are on range. These will be placed in pens adjacent to those of the original birds and trap-nested throughout the coming year. It is proposed to continue these strains indefinitely by selective inbreeding in order to determine the capabilities of each strain and the effect of this method of breeding upon future progeny.

The only incubation problem which is being given serious consideration is the question of amount and cause of embryo mortality. This project is being carried on both at the Station plant and at the Vineland plant. To date it may be said that there has been found a great difference in the hatchability of eggs from individual hens, which leads to the belief that the question of poor hatches is but in rare instances a question of faulty incubation, but rather it is a question of the quality of the hatching eggs themselves. Observation in detail shows that the factors which may contribute to the hatchability of the eggs include breed, age, season, productivity, vigor, vitality and individuality. It is expected that much of value will be derived from this project during the next hatching season.

This department has been carrying on extensive feeding experiments during the past few years, especially on the protein and ash factor in feeding. This fall a new and somewhat unique series of feeding tests will be carried on in an effort to determine which of the so-called protein carriers, such as milk products, vegetable concentrates, etc., can be safely fed or substituted, either whole or in part, for meat scrap. A problem which is being investigated and which is yielding some very interesting results is that relating to the effect of time of hatch upon moult and distribution production. This department has recommended February hatching for at least a part of the poultry flock for the past two or three years, as borne out by the previous reports and circulars. To date there are on the poultry plant flocks of Leghorns hatched the first of

each month from January to July. All of these flocks are being trap-nested in order to eliminate any individuality factor. The season of the moult and the amount of production are being carefully recorded in order to determine the commercial aspect of the question.

A problem which has given this department much concern in the past has been the probability of error in experimental analyses due to the individuality factor of the hens themselves. With the idea of determining the possible error from this source, a considerable number of pens, incubators and brooders have been cared for in their respective ways under identically the same conditions for the purpose of determining as accurately as possible the normal variations in production, or in hatchability, or in brooding. The detailed results of this work will be published from time to time, papers having already been presented at various conferences by members of the department staff. The poultry department is continuing the work of standardization of poultry houses and equipment, and this project is being extended to include the working out of a standard unit poultry plant which shall cover all questions of area, total kind and cost of all buildings, crop rotations, etc.

Numerous minor projects of a laboratory nature which are being continued cover the home preservation of eggs, a study of seasonable price variations in New York markets for poultry products, types and breeds as affecting economic capon production, and the season as a factor in broiler production. Lastly, a careful study is being made of the distribution of poultry diseases in New Jersey. The information which this study will make available should allow the department to be better prepared to meet expected epidemics and to cooperate in combating them. These minor projects are of rather short duration and many of them are observations which can be secured from data obtained from major projects.

The work at Vineland makes possible the most valuable propects now under way. The extreme accuracy of the trap-nest work, the large number of fowls involved, and the great number of breeds and varieties make this work especially worth while. There are four major projects under way at Vineland in addition to the competitive feature of the contest. By far the most important project has to do with the amount, distribution and inheritance of fecundity in the domestic fowl. The three-year breeding feature of the contest, whereby the production of progeny of the present

birds will be studied, makes this contest unique and by far more valuable than a simple one-year contest.

The second project at Vineland which is creating much general interest throughout the state and which will probably be of extreme commercial importance is a study of external characteristics as indicative of a fowl's productive ability, both past, present and future. Much of interest has been published along this line, and results of the findings to date have been used extensively in extension activities. A third Vineland project has to do with the amount and cost of food consumption and its relation to egg production. Lastly, the incubation problem dealing with the causes of embryo mortality will be given serious consideration at Vineland this coming spring, when 10,000 eggs from 1,000 hens will be pedigree-hatched and the chicks pedigree-reared.

The completion of the new poultry farm will make possible from now on much more careful and continued research work. Ever since the creation of the poultry department at New Brunswick, seven years ago, much time has been spent in erecting buildings, fences and equipment. With the completion of the new farm, which is fully equipped for both the commercial and the research project, the work should receive a great impetus. Considered from all angles, the work at present under way is progressing very satisfactorily. The question of securing satisfactory labor of all grades to conduct our work properly is at present the hardest problem.

DAIRY HUSBANDRY

Projects of an experimental, extension and control character have been included in the program of the department of dairy husbandry of the Station.

Mention may be made, among the first, of the following:

1. The comparative value of wet versus dried brewers' grains.
2. An economical ration for wintering dairy heifers under New Jersey conditions.
3. The relation of the conformation of dairy heifers to their future production.
4. The comparative value of eastern versus western alfalfa hay as a feed for dairy cows.

The dairy department has extended the fullest cooperation to the extension service in helping the extension specialist in dairy

husbandry to organize three cow-testing associations and in helping also the initial work of organizing two other cow-testing associations. A number of demonstrations on dairy feeding and dairy records were given. Similar demonstrations on calf feeding were also made in different parts of the state. A number of boys' and girls' cow-testing clubs have been organized, and, in a more general way, advice and help have been given to many dairymen in the state through meetings, correspondence and personal visits.

The large number of pure-bred animals in the state and the keen interest which the owners of registered animals show in advanced-registry testing have imposed a responsibility of considerable magnitude on the dairy department in the matter of official and semi-official testing. The supervision of the official and semi-official records within the state has been placed in the hands of the dairy department and has received careful attention.

From the control standpoint, the members of the staff of the dairy department assumed responsibility for the testing and calibrating of glassware used at creameries and by milk dealers. Examinations have been given to all applicants for testers' licenses.

The equipment of the dairy department has been enlarged by the addition of a considerable number of pure-bred animals to the herd. Among these additions, especial mention may be made of four registered milking Shorthorns, whose purchase was made possible through an appropriation by the State Legislature. Other additions of pure-bred animals to the herd came through natural increase or through gifts from friends of the State Agricultural College and Experiment Station.

SEED CONTROL

A marked feature of the year's work has been an increased demand for service, which increase is proportionally much greater than for previous years. This may be attributed, in part, to the requirements of the new seed law, but more than ever to the increased interest of the purchaser in seed quality. The present war disturbance as affecting costs and other features of production has done much to stimulate an interest which the seed laboratory has continually and persistently attempted to develop through every available means. Every effort will be made by the department to develop fully the advantage thus gained.

The work of the laboratory as it concerns the enforcement of the provisions of the law relating to the labelling of the agricultural seeds cannot be considered more than of a preliminary nature. Through inspection of dealers' stock in various parts of the state, it was learned that many dealers were apparently ignorant of the existence of the law, but in practically every case there was expressed a ready willingness to comply. Strenuous objectors to the law in most cases were supporting objections based on misunderstandings. When correctly informed, they were quite willing to change their attitude.

Samples were taken from labelled goods only. Analysis of these samples indicated that, in the majority of cases, the label statements were reasonably accurate. Those which could not be so considered were mostly supplied by one wholesale vendor. Apparently, publication of the name of the wholesale vendor in connection with each lot of seed will serve to enlighten the retail vendor responsible.

In view of the general situation, it does not appear advisable to resort to prescribed legal action against apparent violations of the seed law. Publication of analyses guaranteed and found, together with a list of those failing to attach any form of label would seem to suffice for the present year. It is intended, however, to issue a statement to the trade to the effect that after November 1, 1917, all dealers will be held strictly to all sections of the law. This is more than reasonable in view of the fact that they have had a year to become familiar with the requirements of the law.

Additional equipment provided will do much to facilitate the analytical work of the laboratory, and increase the degree of accuracy and decrease the time requirement per sample.

Owing to pressing demands of analytical work, little has been developed as investigational work proper. Minor problems affecting particular phases of the analytical work have been given some attention. Preparation as to equipment, etc., is being made for a more intensive study of the relations of seeds and parasitic fungi.

Through publication of circulars and news letters, an effort has been made to stimulate interest and activity in seed production for home use. It is intended to develop this feature to all possible limits by such aid as this department can give in conjunction with the efforts of other departments directly interested in this project.

AGRONOMY

A rather limited amount of work on farm crops was done by the agronomy department within the past year. The limitation has been due largely to inadequate facilities as to land and equipment. However, additional work was started on forage crops, including investigations of the source of alfalfa seed, the time of seeding alfalfa, the value of nurse crops and the rate of seeding. The work on cultural methods also has been continued.

From the standpoint of farm management, the service rendered by the agronomy department has been one of direct and large value. The study has been continued of types of farming in certain portions of the state. The work on the general and dairy farms in Monmouth County has been completed and is in the hands of the printer. The study of dairy farms in Sussex County also has been completed and submitted for publication. An extensive poultry survey has been made in the vicinity of Vineland and Lakewood in South Jersey, and also in the Sussex area in North Jersey. This study is now nearly complete and should be available for publication at an early date.

The records relating to the truck farms of Monmouth County are being tabulated and the information contained in these should also be available for use in the near future.

Cost accounting records were kept on a number of farms, and have been filed for ready reference. Additional studies are to be made of fruit and hog farms in order that the farm management studies carried on in the state may be made fairly complete.

It is hoped that the agronomy department will have placed at its disposal an adequate area of land for the proper testing of varieties of small grains, corn and grasses, and possibly also for the study of important rotations in general farming. It would be highly desirable, when conditions permit, to add to the equipment of the agronomy department a small building in which samples of crops and the necessary tools and implements made be stored. Such additional equipment would make possible the study of potatoes, alfalfa, corn and some of the other important farm crops of wide interest to the farmers in New Jersey.

AGRICULTURAL EXTENSION

Farm Demonstration

The number of organized counties has grown from 11 to 16, and only 2 agricultural counties remain unorganized. The reorganization of county boards of agriculture on a community basis is one of the far-reaching accomplishments of the year. The survey of labor needs by county demonstrators last summer had distinct value, and indicated an ability to attack war problems in an efficient way. There has been close cooperation among county demonstrators, extension specialists, home demonstration and club leaders, which has been a distinguishing feature of extension work in New Jersey from its inauguration. Demonstration work in the various counties is now on a good project basis, and a system of records and reports maintained in the state leader's office enables each demonstrator to keep closely in touch with the work of every other demonstrator. During the year 1,156 demonstrations were carried on throughout the state, classified as follows: cover crops, 145; lime and fertilizer, 83; alfalfa, 241; corn, 23; soybeans, 27; potatoes, 155; truck crops, 88; orchard work, 111; dairy, 178; poultry, 68; miscellaneous, 42.

Fruit Growing

The work of the specialists in fruit growing has been interrupted by resignations due to army enlistments. The leading projects are: orchard management, substitute spray for peaches, fruit survey work, top-working of apples and peaches, spraying of peaches and apples for the production of perfect fruit. Taken as a whole, the demonstrations have been unusually successful in teaching lessons of value during the last year. Ninety-five meetings were held, with a total attendance of 3,100. The number of farms visited is 750.

Market Gardening

The extension specialist in market gardening has been concerned with definite projects, dealing with onion-maggot control, the development of disease-resistant strains of cabbage, desirable early tomato strains, and cantaloupe and field bean production, together with some minor projects, while seeking to meet the special demand for services, due to the war. He addressed 68 meetings,

with a total attendance of 8,076, and wrote over 2,000 letters. His bulletin on the Home Vegetable Garden was revised and 100,000 copies of it sent out by the State Department of Agriculture.

Soil Fertility and Agronomy

The specialist in soil fertility and agronomy has followed up his project to determine the value of vast areas of waste land in the state, and results are most encouraging. It is planned to make use of lime, phosphorus and inoculated legumes, thus saving the purchasing of nitrogen and potash. Results so far indicate that some types of soils covering large areas of the state and now unproductive can be brought up to the point of alfalfa production by the use of lime, phosphorus and such legumes, and the increase in productive power is very marked. Some alfalfa seed tests have demonstrated that New Jersey's supply should come only from the North-Central and Northwestern states and that seed from the Southwest should be avoided. California seed gave inferior results, and this was likewise true of Turkestan and some Russian strains. Community corn demonstrations were continued with good interest and profit. Necessarily, a great deal of time was devoted to emergency work and to the assistance of demonstrators in newly organized counties.

Poultry Husbandry

New Jersey has large poultry interests, and the project work of the specialist in poultry husbandry has attracted much attention. The number of demonstrations was 292, and 590 visits were made. In addition, there were 154 educational demonstrations given, and 10,500 people were addressed at 237 meetings.

Dairy Husbandry

War prices of dairy feed have narrowed the margin of profit in milk production, and the extension specialist has found that his dairy record associations have become more popular than ever. The five which have been in existence are maintaining their membership, and three new associations have been organized during the year. A considerable number of feeding demonstrations have been carried on, and a direct financial saving to the dairymen has been shown.

Home Demonstration

Home demonstration work has been peculiarly acceptable in the state this year, on account of the emergency created by the war. There have been 121 canning demonstrations, 26 on the drying of fruits and vegetables and 43 along other lines. The total number of people reached was 22,888. Three counties have organized for the maintenance of home-demonstration workers, and agents maintained largely from emergency funds are being placed in other counties and in the larger cities. The leader in this work is co-operating closely with the National Food Administration and its state representative, and also with women's clubs. There is such cooperation and coordination of work that the national and state agencies are dealing directly with the food problem work in the closest touch with the college.

Boys' and Girls' Club Work

The boys' and girls' club work, which has grown into such popularity throughout the United States in recent years, is now placed on a more permanent basis in our state through cooperation with the Department of Public Instruction. A limited number of county leaders from the teaching staff of the counties are employed on emergency funds to give their entire time during the summer vacation months for supervision of the club work that is under way. The extension division directs and supervises the project work from the agricultural and home economics point of view, while the Department of Public Instruction, of course, retains within its jurisdiction everything that determines the place that club work shall have in the schools.

SOIL CHEMSTRY AND BACTERIOLOGY

The experimental work of this department has been successfully carried on during the past year in very much the same manner as in previous years. Some new work has, however, been added to meet the demands for more specific information with reference to the fertilizer requirements of corn and potatoes.

Nitrogen Availability

Field and Cylinder Experiments

This year completes the second 5-year period for most of the field work. The yields of timothy on the nitrogen-availability plots were only fair, the average for the unlimed plots being 2,562 pounds per acre, and for the limed plots 2,472 pounds per acre. The smaller yields from the limed than from the unlimed plots is contrary to general experience and to expectations. As an explanation, it is suggested that the liming may have resulted in a more rapid depletion of the nitrogen on these plots than on the unlimed plots and, therefore, in the absence of a leguminous crop in the rotation, the limed plots are actually more deficient in available nitrogen than the unlimed plots. The fact that during the earlier years of the experiment the yields were usually greater on the limed than on the unlimed plots would seem to justify this explanation.

The highest yield obtained was 2¼ tons per acre.

As showing the value of lime with timothy, it may be pointed out that in the lime and rotation experiments where the amounts of nitrogen available for the crop is not limited to that which is applied in the form of commercial fertilizers (a part of the nitrogen being supplied by the clover, the limed plots invariably gave a larger yield than the unlimed plots.

This year also completes twenty years of work on the availability of different nitrogenous materials with Penn loam soil in cylinders. A good crop of timothy was harvested from these cylinders and samples have been prepared and analyzed as usual. It is of interest to note that the results confirm the results hitherto reported with reference to the availability of nitrogen in the different materials. Nitrate of soda again stands highest with a recovery of 55.77 per cent of the applied nitrogen. Sulfate of ammonia, farm manure and dried blood follow in the order named, with recoveries of 41.75 per cent, 29.85 per cent and 29.41 per cent, respectively.

In the cylinders with soil of varying mechanical composition, nitrate of soda has likewise shown a higher availability than dried blood. The average recovery for nitrate of soda in the ten series (representing the variations in mechanical composition) being 61 per cent of the applied nitrogen, and for the dried blood 30 per cent.

Nitrogen Accumulation and Utilization

Field and Cylinder Experiments

The yield of wheat and rye on the continuous wheat and rye plots was unusually low, due no doubt to the gradual depletion of the supply of soil nitrogen. But the wheat plot which is each year seeded to soybeans immediately following the wheat harvest, yielded 5 bushels more of wheat per acre than the plot that is left in stubble between wheat harvest and wheat seeding. This is not as large an increase as has been obtained during the past few years, but it indicates what may be done with leguminous green crops under proper management. The soybeans in the lime and rotation tests have not yet been harvested but it is very evident that those grown on the limed plots are decidedly better than those grown on the unlimed plots. A count of the number of nodules on the roots of plants from limed and unlimed plots made about the middle of July shows an average of 85 nodules on the plants from the limed and 37 nodules on the plants from the unlimed plots. The cowpeas and oats and Canada field peas have also given larger yields with than without lime.

The four alfalfa plots have again yielded three cuttings, though the third cutting was small as a result of the continued dry weather. Here again the limed plots have averaged from a few hundred pounds to 1,000 pounds more of hay than the unlimed plot.

Cylinder work on nitrogen accumulation and utilization has been carried on as usual. All the crops have been harvested and have already been prepared or are being prepared for analysis. Definite conclusions cannot be drawn until all weights have been tabulated, but so far one can tell from appearances that a larger yield has been obtained, in most cases, where nitrogen was secured in the form of leguminous green manure crops (grown between the main crops) than from either nitrate of soda at the rate of 160 pounds per acre or stable manure at the rate of 15 tons per acre every two years. The increased yield of corn where the nitrogen was secured in the form of green manure crops as compared with the other forms of nitrogen, is especially noticeable.

The Corn Fertilizer Experiment

On account of the unusually high price of corn and the increased interest in the use of corn as food, it seemed worth while to carry on fertilizer experiments to secure further data as to the fertilizer requirements of this crop, especially the nitrogen requirements. Forty-four plots were laid out adjoining the soil-fertility plots, and were so arranged that the fertilizer treatment could be duplicated. Nitrate of soda was used alone, in varying amounts, and also with acid phosphate. Varying amounts of a 4-10-0 mixed fertilizer also were used. The crop has not been harvested, but pronounced differences have been noted. It is quite evident, however, that the soil is not uniform and the results therefore cannot be all that would be desired. Indeed it is recognized that the results of more than one year are required for anything like definite conclusions, but data secured by means of this experiment will at least help in planning future work.

Potato Fertilizer Experiments

In response to a request from potato growers of the state for definite information in regard to the fertilizer requirements of potatoes, two cooperative experiments were undertaken. After carefully looking over the ground it was decided to locate one of these at Mt. Holly on the farm of Mr. J. A. Jones and the other one near Elmer, on the farm of Mr. J. Harry Kandle.

Forty-eight plots were laid out, and with slight exception, the fertilizer treatment was the same on the two farms. The treatment was also (with slight exception) duplicated in each case, thus in reality giving four parallel treatments.

The soil at Mt. Holly is a fine sandy loam and at Elmer a heavy loam, both being of the Sassafras type. At Mt. Holly, Giants were planted, and at Elmer, Irish Cobblers. The treatment provides for varying amounts of a standard mixture (4-8-3) starting with 800 pounds per acre and running up to 2,800 pounds in 400-pound steps. It provides the nitrogen in this standard from different materials, as for example, nitrate of soda, sulfate of ammonia and organic materials, each used alone, and also combinations of these materials; it provides a formula with nitrogen and phosphoric acid but no potash and also formula with 3, 6 and 10 per cent of potash. Check plots were introduced at intervals and

also a few plots were provided with greensand marl as a source of potash, and a few others with ground limestone.

The potatoes have been dug and the crop from each plot weighed so that the results can be calculated to the acre basis. The detailed results cannot be recorded here but the following general statement may be made.

A. The Work at Mt. Holly

In the Mt. Holly experiment the average yield from 4 plots that received a treatment equivalent to 1,600 pounds per acre of a 4-8-0 (potash omitted) fertilizer is less than the average for the check plots (no fertilizer). It is not entirely clear why this fertilizer should have actually depressed the yield. It is possible, however, that it may be the result of an unbalanced fertilizer, that is, an excess of nitrogen over available potash.

Compared with the mixture containing 3 per cent of potash the mixtures containing the higher percentages (6 and 10) seem to have slightly depressed the yield.

Where the nitrogen was derived entirely from ammonium sulfate the yields were slightly less than the yields on the check plots. Judged by the results of this experiment there is not much difference between fish and tankage as a source of nitrogen, nor was there much difference between the nitrogen as nitrate and as organic materials.

The figures do not seem to justify the use of more than 1,200 to 1,600 pounds per acre of such a fertilizer as was taken for the standard, but in making this statement it must be taken as applying to this season only. Had the rainfall been more evenly distributed the result might have been different. For some reason the vines deteriorated rapidly after about the second week in July and as a result the yields were generally low and the potatoes small.

B. The Work at Elmer

The soil on which this experiment was conducted had not been limed since 1911 but notwithstanding this fact, some of the plots produced a large percentage of scabby potatoes. It is significant that the two plots where ammonium sulfate was used as a source of nitrogen produced very few scabby potatoes; on the other hand, the total yields on these plots were low. Beyond this the work

has not been carried far enough to make it possible to say whether any connection may be traced between the prevalence of scab and the kind of fertilizer used.

The potatoes were graded into "Firsts," "Seconds," "Thirds" and "Scabby." The "Thirds" were not marketable and the scabby potatoes were sold at a price a little below the others. Only a brief summary can be given here and hence the total yield per acre is given rather than the yield by grade.

The average yield of four check *plots* was at the rate of 220.2 bushels per acre.

The average yield of five check *rows* which ran the full length between the blocks of plots at intervals of 18½ feet was at the rate of 201.5 bushels per acre.

The average of two plots that received 800 pounds of a 4-8-3 was at the rate of 255 bushels per acre.

The average yield of two plots that received 1200 pounds of a 4-8-3 was at the rate of 287.9 bushels per acre.

The average yield of four plots that received 1600 pounds of the standard 4-8-3 was at the rate of 285 bushels per acre.

The average yield of twenty plots that received 1600 pounds of 4-8-3 (nitrogen secured from different sources) was at the rate of 285.2 bushels per acre.

The average yield of two plots that received 1600 pounds of 4-8-6 was at the rate of 295 bushels per acre.

The average yield of two plots that received 1600 pounds of 4-8-10 was at the rate of 277.7 bushels per acre.

The average yield of two plots that received 2000 pounds of 4-8-3 was at the rate of 291.25 bushels per acre.

The average yield of two plots that received 2400 pounds of 4-8-3 was at the rate of 317.9 bushels per acre.

The average yield of two plots that received 2800 pounds of 4-8-3 was at the rate of 311.46 bushels per acre.

The average yield of three plots that received 1600 pounds of 4-8-0 was at the rate of 240.7 bushels per acre.

The average yield of four plots that received 1600 pounds of 4-8-0 and 2½ tons of greensand marl was at the rate of 269 bushels per acre.

With only one season's work it is unsafe to undertake to draw any very definite conclusions from such figures. It may be noted, however, that without fertilizer this soil seems capable of producing 200 to 220 bushels of potatoes per acre. With 1,600 pounds of 4-8-3 it seems capable of producing about 285 bushels per acre. It would thus appear that 1,600 pounds of fertilizer means an increase of 65 to 85 bushels of potatoes per acre.

Practically the same yield was obtained with 1,200 pounds of 4-8-3 as with 1,600 pounds, but in the case of the 1,200 pounds only two plots could be averaged, and the yield on one of these was distinctly higher than on the other.

The yield with 1,600 pounds of 4-8-0, that is, a fertilizer without potash, was approximately 45 bushels under the yield obtained with

an equivalent amount of fertilizer in which there was 3 per cent of potash.

The yield with 800 pounds of 4-8-3 was about 30 bushels under the yield with 1,600 pounds of the same material.

Applications above 1,600 pounds per acre gave increases varying from a few bushels to more than 30 bushels per acre.

The ten per cent potash mixture yielded less than the 3 per cent mixtures.

Potash in the form of marl when used with the 4-8-0 gave an increase of nearly 30 bushels over the plot receiving the same fertilizer without potash.

The amount of the standard fertilizer which may be used with profit must necessarily depend upon the price of the fertilizer and also the price which the grower expects to get for his crop, and as already mentioned, much will depend upon the season. In a dry season, a heavy application cannot be fully utilized, whereas in a wet season it might be. Likewise, the type of soil will have much to do with the amount of fertilizer to be used. A heavy moist soil will bear a heavier application than a light soil which dries qnickly. It is hoped that this work will be continued for at least another year in one or both of these places.

Soil Survey Work

The work of the soil survey in which the state is engaged, in co-operation with the Bureau of Soils of the United States Department of Agriculture and the State Geological Survey, has been continued, and during the past winter about 66 samples of soil representing the Belvidere and Millville areas were analyzed. During the summer additional samples were collected from the Belvidere area.

The analytical work on about 150 samples from the Camden area has been completed and tabulated, and only a little more work will be required to bring this material into shape for publication.

Sulfur Oxidation Work

A large amount of preliminary work has been done to determine to what extent the sulfuric acid formed by the oxidation of sulfur in the soil will act upon raw rock phosphate to make this available.

The results, a part of which have already been published, have proved quite encouraging.

Soil Biology Projects

The rate of decomposition of organic matter is being determined, taking the amount of carbon dioxide produced as the index of activity, and comparing this with the ammonia accumulation.

A study is being made also of the effect of liming upon biological activity as shown by carbon-dioxide production, ammonification, nitrification and counts.

During the year the following have been prepared and published:

Bulletin 305. Maintaining the Nitrogen Supply of the Soil.

Bulletin 309. The Chemical Composition of the Soils of the Freehold Area, N. J.

Circular 67. The Potash Question and General Farm Crops.

BOTANY

The researches for the year are embraced by the following three projects: (1) Heredity, (2) Environment, (3) Toxicology.

Under Heredity the subjects have been the same as for the previous year, there usually being an advancement of one generation in the crosses and hybrids. Emphasis has been laid upon certain factors, as for example, those for color in tomatoes, eggplants and peppers. In tomatoes the thickness of skin has been under consideration with a reasonable hope of securing a marketable size of fruit, combining the tough skin of a strain that was found among the crosses but associated with small fruits.

The breeding work in eggplants has been chiefly with the inheritance of bitterness in the flesh and for the production of a commercial kind that is free from prickles, especially upon the calyx.

Among peppers the leading features are: (1) a study of adherence of type in the fourth and fifth generations; (2) the behavior in breeding of plants the fruits of which have an unusual series of maturation colors. In all three of the above vegetable plants the work of reciprocal breeding is passing into its third season with some indications that there is a difference in the progeny depending upon the direction in which the cross is made.

Under Environment the work is mainly with the position of the fruit upon the plant, and of the seed in the fruit as related

to viability and vigor. These studies warrant the opinion that location upon the plant and in the fruit are modifying environmental factors. It is likely that the final results may stress the importance of seed selection with regard to this position upon the plant, probably through the correlated character of size and by a process of sifting.

Studies are in progress in connection with influence outside of the plant and chiefly with depth in planting of corn, beans, and soybeans and peanuts.

Under Toxicology the work in the greenhouse has been chiefly with soybeans and buckwheat and (1) concerning the injurious effect of excessive amounts of salts in soil, sand and water cultures; (2) the effects of combinations of fertilizer salts, and in particular whether such combinations are equally helpful to seedlings and to maturing plants. A study is also being made of the ill effects of poorly-balanced combinations of fertilizer salts.

ENTOMOLOGY

The correspondence of the department was the same as that of last year and involved the writing of twenty letters for each working day.

Apple orchards suffered rather severely from plant lice and curculio attacks. Through the month of July vegetables of all sorts were attacked by plant lice. Really severe injury was done in the northern half of the state. In the late summer and early fall a pest of tussock moths appeared on the elms and other shade trees partially or completely defoliating them. Fortunately, the lateness of the attack will minimize the injury, for he buds were formed before the defoliation had proceeded far.

Orchard plant louse, vegetable plant louse, and tussock moth nformation looking toward control was distributed, as the occaion seemed to demand.

Investigations

The problems that called for serious consideration included he following:

1. Mosquitoes
2. Climate and insects

3. Greenhouse insects
4. Housefly
5. Orchard insects
6. Small fruit insects
7. Vegetable insects
8. Soil-infesting insects

Mosquitoes

There have been cut 214,286 linear feet of ditches 10 inches wide and 30 inches deep, or their equivalent, on the salt marshes of Ocean and Cape May counties. One contract of 100,000 linear feet was placed in Upper Township of Cape May County on both sides of Beesley's Point; and another of 114,286 feet in Little Egg Harbor Township of Ocean County, lying between Deep and Roundabout creeks and Great Bay.

At a cost of 11 cents per capita, 100,000 acres of partially and completely drained salt marshes have been patrolled by the county mosquito commissions and residual breeding destroyed in so far as possible. About 2,000,000 linear feet of new ditching have been cut, and the entire upland of Hudson, Bergen, Essex and Union, of the populated portions of Atlantic, of the cities of Paterson and Passaic and adjacent municipalities amounting to 415,500 acres, have been patrolled, many of the remaining permanent breeding places therein permanently eliminated by drainage and all breeding destroyed in so far as possible.

The New Jersey Mosquito Extermination Association, an organization founded about four years ago to further the cause of mosquito control, has now increased to about 1,600 members.

The investigations of the present year have served further to emphasize the necessity for close cooperation between the mosquito fighting units by determining the fact that the fresh-water swamp mosquito does on occasion migrate at least 10 miles from the place of breeding. They have served to demonstrate that this species breeds on the edges of the banked-in and otherwise protected salt marshes, sewage-charged waters of the Passaic River and other streams and of salt marshes, in temporary and permanent pools on the upland everywhere, whether clean or foul. They have served to show that this species, next to the salt-marsh forms, is the most difficult to control and in the northern half of the coastal border represents the next problem.

Climate and Insects

It has been determined that atmospheric humidity conditions the life of the bean weevil (*Bruchus obtectus* Say), that a high moisture (100 per cent) encourages the growth of fungi which destroys both the beans and the weevils, that the highest degree of moisture which will fail to encourage fungi (about 75 per cent) is most favorable, and that low moisture (26 per cent or below) will prevent reproduction. From a practical standpoint this means that beans may be protected from weevil attack by subjecting them to a dry atmosphere, such as may be had by storage in lime. The angoumois grain moth, a serious pest of corn in storage, has been found to be similarly sensitive to low moisture and it is likely that seed corn could be protected by storing it in a dry atmosphere.

Greenhouse Insects

An apparatus, by means of which the concentration of hydrocyanic acid gas in a greenhouse can be determined, has been devised and a mass of data on the distribution of this gas under greenhouse conditions has been accumulated. These studies show that the maximum concentration throughout the house is reached in 8 minutes or less, and different greenhouses exhibit peculiarities of distribution (high concentrations at some points and low at others, in some cases killing the plants at the former and leaving the insects unhurt at the latter). The multiplication of the points of gas discharge seems to tend to correct inequalities in distribution, and difference in tightness of glazing will render a satisfactory charge in one house deadly to the plants of another if it is more tightly glazed.

House-Fly

In cooperation with the Borough of Beach Haven a practical fly campaign was undertaken and carried out. All breeding places were plotted and treated, and poisoned bait stations were established and maintained. Although the control of breeding was not entirely satisfactory, the house-fly and its relatives were at no times abundant or troublesome. The green-head fly visited the bait stations, fed on the material and was killed.

Orchard Insects

An attempt to control apple plant lice through the destruction of their eggs during the dormant season has shown that about 95 per cent are destroyed by coating them with winter-strength lime-sulfur and that about 98 per cent are killed when they are wetted with a 2 per cent aqueous solution of crude carbolic acid to which enough soap has been added to break surface tension. The lime-sulfur appears to harden the egg so that it does not hatch. The carbolic acid, on the other hand, appears to penetrate and soon to result in shrinking. The efficiency of the lime-sulfur appears to be increased by the addition of 40 per cent nicotine at the rate of 1 to 500. The miscible oils gave less satisfactory results, sealecide killing about 45 per cent and Mechling's scale oil about 85 per cent. It is significant that the former is said to have no phenol while the latter contains a considerable percentage.

The discovery of the three-layered nature of the plant louse egg together with the fact that the outer-layer splits from 2 to 8 days before the egg hatches explains the formerly noted increased susceptibility of the egg just before hatching to winter-strength lime-sulfur. Practical field tests have shown that through spraying the apple trees at the green-bud stage, or just before the little leaves stick out like squirrel ears with a mixture of winter-strength lime-sulfur and 40 per cent nicotine at the rate of 1 part to 500 of the lime-sulfur, gives excellent control. The nicotine kills the lice that have already hatched and the combination destroys the eggs that have not yet hatched.

Three tests were made of methods already advocated for control of pear psylla. In two cases, although winter treatments were neglected, satisfactory control was obtained; in the third, in spite of winter treatments, the control was unsatisfactory. In the last, too many flies had yet to lay their eggs when the spring treatment was given. In view of these facts, it seems probable that winter treatments may be omitted, that 40 per cent nicotine should be added to the winter-strength lime-sulfur (1 to 500) which is applied just before the blossoms open, and that the treatment must be very thorough.

Studies of the control of the peach borer show that poisoning the adults will not effect a control because as many as 500 eggs

may be laid before food is taken, and that control by destruction of the eggs involves a treatment every nine or ten days, beginning July 15. The effect of sprays to protect by poisoning the young larvæ and the effect of card collars to prevent the young caterpillars from entering the trees cannot be reported on because the data are not yet all collected.

Small Fruit Insects

The machinery necessary to apply the sulfur-arsenate-of-lead dust for the control of the strawberry weevil has been tested. A small sreen wire sifter made by covering a horse wire muzzle with wire cloth and fitting it with a handle about eighteen inches long is best for applying the dust to patches and small fields. An engine-driven dusting machine seems best for large acreages. The one modified for the purpose and tested was the smaller type of the power dusters made by he Niagara Sprayer Company. With such a machine about 25 acres can be treated each day.

Vegetable Insects

All attempts to control the seed corn maggot in lima bean seed were a failure, but a mass of negative data was secured and some clues to successful procedure obtained. The fly exhibits a great fondness for sweetened liquids, which may be poisoned, and a great aversion for tar. By taking advantage of one or both of these reactions, a method of control may be worked out.

Vegetable plant lice were very abundant this year on all sorts of vegetables. Application of a mixture composed of one part of 40 per cent nicotine to 500 parts of water to which soap had been added at the rate of 2 pounds to 50 gallons in such a fashion as to wet thoroughly all the lice gave satisfactory control in every case. A number of extension projects on the control of various vegetable insects were planned by the entomologist but the reports of results are not at hand. They are in the notes of Mr. Huber and Mr. De Baun.

Soil-Infesting Insects

In laboratory experiments, it was found that sodium cyanide applied to the soil at the rate of 100 pounds to the acre destroyed 100 per cent of a wire worm infestation, but the same material applied to the soil under natural conditions utterly failed to destroy wire worms of the same species. Such heavy charges were required that the cost rendered its use impracticable.

PLANT PATHOLOGY

A number of resignations from the staff of our plant pathology department are to be noted. Messrs. W. S. Krout and H. C. Lint resigned—the former to accept an appointment at the Massachusetts Agricultural Experiment Station, and the latter to accept an appointment with the Alphano Humus Company, of New York City. Mr. C. M. Haenseler was called to the colors early in September. Mr. R. F. Poole, a graduate of Clemson College, South Carolina, was appointed to fill the vacancy created by the resignation of Mr. Krout.

During the past season, peach yellows have been very destructive. The mosaic of tomatoes was less abundant than usual, but fusarium wilt is increasing. The diseases of potatoes were less abundant than usual, but the heavy rains about the middle of July were followed by a very great abundance of tip burn and early blight. The fire blight on apples and pears was much less in evidence than it has been during the past two years. Shade tree troubles caused more complaint than in the past.

The following is a list of the more important projects now carried on by the department: spraying of potatoes; tests with diseased seed potatoes; study of the root and stem rot of celery; tests on the *septoria* blight of tomatoes; studies on fungi injurious to paints. A number of minor experiments also are underway.

It is recommended that the extensive herbarium of the department be rearranged and kept in good condition. The large demand for service in the state does not allow the present staff to give much attention to the herbarium. Provision should be made for a careful and thorough survey of the plant diseases of the state in order that correct information may be obtained as to distribution and amount of injury caused. There is a continuous demand from farmers and others in the state for the study of diseases of truck crops, field crops and ornamental plants.

OYSTER PROPAGATION

The enlisting of Thurlow C. Nelson, in charge of the research work on oyster propagation, made necessary a rearrangement of the investigational work at the Oyster Laboratory and Observation Station. Mr. P. C. Cameron, for some time connected with this

work, has had sole charge of the experiments and observations during the summer and early fall.

Important additions have been made by Mr. Cameron to our knowledge of oyster propagation. His observations show that late spawning and fry swarming occurred in full measure during the season of 1917. It had been noted that, in the season of 1915 and 1916, maximum fry appeared about the middle of October. On the other hand, in the present season, the maximum fry appeared on October 28 and 29 and November 2, 3, 4, 5 and 6, and is still continuing. These observations show, therefore, that the claims of other investigators that oyster spawning could not take place in water under a temperature of 70° F. were in error. The water temperatures of 1915-16, up to October 30th, range from 40° F. to 60° F., when the maximum spawning occurred. In the present season, the temperatures were lower, viz.: from 35° F. to 45° F. A pail of sea water collected by Mr. Cameron on November 5th, at a temperature of 44° F. and with a salinity of 1.017, contained 60 baby oysters, about 12 to 30 hours old, in normal condition. This swarm proved lively in water which fell to 32° F. These findings indicate that studies on oyster propagation should not be limited to the summer months, but should be continued in the fall. As pointed out by Mr. Cameron, the study of the life history of the oyster during nine months of the year has been neglected. It is Mr. Cameron's purpose to continue his investigations during the rest of November and December. It is expected that his observations will add materially to our knowledge of oyster propagation.

FIELD CROPS

A statement is submitted below as to the acreage of the different farm crops at the College Farm in the season of 1916 and 1917, respectively.

Crop	Acreage 1916	Acreage 1917
Timothy	36.0	28.0
Alfalfa	16.0	30.5
Oats and peas	19.5	23.5
Corn	37.0	42.5
Alfalfa seeding	22.0	8.0
Rye, for grain		9.0
Rye, for forage	3.0	4.0
Soybeans for cover crop	3.0	16.5
Total	136.5	162.0

It will be noted that in 1917 there was an increased acreage of alfalfa, oats and peas and corn, as well as of soybeans grown as a cover crop.

It was possible to increase the acreage under cultivation, thanks to the generosity of Mr. W. G. Bearman, who placed at the disposal of the College Farm, without charge, a field of nine acres on which corn was grown for the silo. A tract of nine acres, purchased by the trustees of the College and designated as the Hill Tract, was used in part for the growing of silage corn.

Some progress has been made in the clearing of cut-over woodland at the College Farm and in the drainage of some of the fields at the dairy farm. The labor conditions were very unsatisfactory and an effort has been made to utilize labor-saving machinery. Two tractors, purchased from the Home Defense League of New Brunswick, have been used to good advantage, and it is expected that greater use will be made of them during the season of 1918.

THE STATION LIBRARY

The Experiment Station library, consisting of about five thousand bound volumes and a large collection of unbound agricultural pamphlets and journals, is conducted as a branch of the Rutgers College Library. It is used consistently by the students in the long and short courses in agriculture, the graduate students and the Agricultural College and Experiment Station staff. The librarian's records show that during the year about nine hundred volumes and unbound pamphlets or journals were loaned. Borrowing relations also were maintained with the Library of the United States Department of Agriculture at Washington, D. C., and a large number of items obtained for the use of the members of the staff.

The stock of the library has been constantly increased by the addition of current bulletins, circulars and periodicals, as well as bound volumes. Some progress has been made in obtaining missing pamphlets to complete sets for binding. During the summer the preparation of a new catalog for the bound volumes was undertaken, which at this time is nearly completed.

The needs of the library may be summarized as follows: (1) clerical help, (2) shelf and floor space, and (3) new books. The first need will be provided for after November 1, 1917, when a young lady assistant who has been trained in library work will devote her entire time to the management of the library. This should make it possible to keep the sets of pamphlets and periodicals com-

plete, and to accomplish considerable binding that needs to be done. There is reason to believe that under the new arrangement the organization of the library will be placed on an efficient basis.

The library is greatly overcrowded and the matter of space presents a serious problem. A large number of books which are needed at the Agricultural Building could be transferred from the College Library if room could be provided. More space for reading tables and filing cabinets also is urgent.

Finally, the collection of agricultural textbooks needs to be brought up to date. Most of the author books on hand consist of the earlier works on various agricultural topics, and of the older editions. A good collection of the later agricultural books, including new editions of the standard works already on the shelves, is essential if the library is to render the most efficient service to those who use it.

PUBLICATIONS

The activities of the editor for the past year have been concerned with the following: (1) regular publications of the Experiment Station, (2) publications of the Division of Extension, (3) special publications and (4) special publicity material.

A list of the publications of the Experiment Station is present herewith:

Bulletins

298 Report of the Director for 1916.
299 The Influence of Salinity on the Development of Certain Species of Mosquito Larvæ and its Bearing on the Problem of the Distribution of Species.
300 A Biological Study of the more important of the Fish Enemies of the Salt-Marsh Mosquito.
301 Analyses of Materials Sold as Insecticides and Fungicides.
302 Results of Seed Inspection, 1915-1916.
303 Analyses of Commercial Fertilizers and Ground Bone; Analyses of Agricultural Lime.
304 Fertilizer Registrations for 1917.
305 Maintaining the Nitrogen Supply of the Soil.
306 Some Recent Advances in the Knowledge of the Natural History and Control of Mosquitoes.
307 The Domestic Flies of New Jersey.
308 The Cattleva Fly.
309 The Chemical Composition of the Soils of the Freehold Area, N. J.
310 The High Calcium Content of some Cucurbit Vines.
311 Commercial Feeding-Stuffs and Registrations for 1917.
312 Farm Profits and Factors Influencing Farm Profits on 284 General Farms and 75 Dairy Farms in Monmouth County, N. J.

313 The Parasitic Fungi of New Jersey.
314 Analyses of Commercial Fertilizers, Fertilizer Supplies and Home Mixtures.

Circulars

29 Peach Leaf Curl. (Reprint.)
48 Bordeaux Mixture. (Reprint.)
63 A Substitute for Self-Boiled Lime-Sulfur and other Summer Sprays for Peaches.
64 A Press for the Georgia Carrier.
65 The 1916 Tests of Sulphur-Arsenical Dusts against the Strawberry Weevil.
66 Regulations and Instructions Relating to the Labelling, Inspection and Analysis of Seeds in New Jersey.
67 The Potash Question and General Farm Crops.
68 Common Diseases of Cucumbers and Melons.
69 Corn.
70 Field Bean Production.
71 Diseases of Tomatoes.
72 The Seed Situation.
73 Dairy Feeding and the Calculation of Rations.
74 Digest of and Copy of Revised Feeding-Stuffs Law.
75 Spray Calendar for Apples and Quinces.
76 Spray Calendar for Pears.
77 Spray Calendar for Sweet Cherry.
78 Spray Calendar for Plum.
79 Spray Calendar for Peach.
80 Common Diseases of Apples, Pears and Quinces.
81 Common Diseases of Peach, Plum and Cherry.
82 Packing Peaches in Georgia Carriers.
83 Pruning Experiments with Peaches: Results of First Two Seasons.
84 Common Diseases of Beans and Peas.
85 The Value of Cover Crops.
86 Saving Beans and Peas for Food and Seeding Purposes.
87 Wheat and Rye.

Reports

37-1916. Thirty-Seventh Annual Report New Jersey State Agricultural Experiment Station, and Twenty-Ninth Annual Report New Jersey Agricultural College Experiment Station.
Hints to Poultrymen (monthly). Vol. V, No. 2 to 12, and Vol. VI, No. 1.

Circulars 69, 70, 72, 85, 86 and 87 may be mentioned as emergency circulars, issued to meet the unusual conditions arising from the war situation.

A list of the regular publications of the division of extension in agriculture and home economics of the State Agricultural College follows:

Vol. 1, No. 7. Milk and Eggs. (Reprint.)
Vol. 1, No. 11. The Improvement of the Poor Soils and Run-Down Soils in New Jersey.
Vol. 1, No. 12. Winter Storage of Vegetables for the Home.
Vol. 1, No. 13. Fourth Annual Report for the Division of Extension for the Year ending October 31, 1917.
The Weekly News Letter, Vol. III, No. 1 to 52.
The Farm Demonstration Exchange (monthly), Vol. III, No. 1 to 11.

Also, the monthly news letters and annual reports of the offices of county farm demonstration in the state, while not published at the College, passed through the hands of the editor.

Believing that the bulletin and the circular fail to reach a large proportion of the farmers of the state, the poster was resorted to as one of the most efficient means of reaching the public, especially as an emergency measure. Accordingly, the following poster bulletins were issued during the spring and summer:

Poster Bulletin A. How to Pack Peaches.
Poster Bulletin 1. Grow Cover Crops.
Poster Bulletin 2. Sow More Wheat and Rye.

The first of these was used mainly at demonstrations in packing peaches, and the other two, which were printed in larger editions, were distributed through the county agents, granges, post offices, banks and railroads. These agencies were found to be very willing to cooperate in placing the posters where they would be effective, and there is reason to believe that this form of publicity had a material effect upon the agriculture of the state.

During the past year the editorial office has operated a local news service in the form of the "Experiment Station News," a mimeographed sheet recording the news items of interest at the Agricultural College and Experiment Station. Its object is to keep the staff members informed of the more important occurrences affecting the institution, and also to furnish news for the local city press. For several months it was issued weekly, but recently it was decided to condense it and issue only once a month.

Mention should be made also of "Soil Science," an international monthly scientific journal, published by the Williams and Wilkins Company, of Baltimore, Md., under the auspices of Rutgers College. This journal makes possible the conservation of a large part of the Experiment Station's funds for printing. The editorial work of "Soil Science" is performed at the Experiment Station and many papers prepared in the different departments are accepted for publication. Otherwise, it would be necessary to publish many of these as bulletins of the Experiment Station.

The poultry department has conducted a well organized press service in connection with the Vineland International Egg Laying and Breeding Contest. The following press notices have been issued regularly:

Vineland Contest Weekly Press Bulletin, Vol. 1, No. 1-52.
Vineland Contest Monthly Press Bulletin, Vol. 1, No. 1-12.
Vineland Contest Monthly Press Report, Vol. 1, No. 1-12.

In addition to the publicity secured through the Weekly News Letter of the division of extension, some special publicity work for the Experiment Station was undertaken near the close of the year. The services of a news agency furnishing material for the important daily papers of New Jersey was obtained, and special stories of the Experiment Station sent in every few days. Through the services of a clipping bureau, follow-up work is being carried on.

A complete revision and re-classification of the mailing list has been begun. The publications henceforth will be classified under various farm topics, such as "farm crops," "poultry," "dairying," etc. Return post cards were sent to all addresses on the mailing list, asking each person who wished to have his name retained on the list to check the subjects in which he was interested. In this way an accurately classified list will be built up, and through the use of an addressing machine equipped with a selective device, only those publications in which each individual on the mailing list is interested will be sent in each case. This will make possible a considerable saving of printing funds, since it will not be necessary to print such large editions of the bulletins and circulars as heretofore.

PAPERS BY STAFF MEMBERS

The following papers by members of the staff have appeared during the past year:

Technical Papers

"The Yield and Nitrogen Content of Soybeans as Influenced by Lime." J. G. Lipman and A. W. Blair, *Soil Science*, vol. 4, no. 1, July, 1917.

"Vegetative Experiments on the Availability of Treated Phosphates". J. G. Lipman and H. C. McLean, *Soil Science*, vol. 4, no. 4, October, 1917.

"Total Nitrogen and Carbon in Cultivated Land and Land Abandoned to Grass and Weeds." A. W. Blair and H. C. McLean, *Soil Science*, vol. 4, no. 4, October, 1917.

"Sulfur Oxidation in Soils and Its Effect on the Availability of Mineral Phosphates". J. G. Lipman, H. C. McLean and H. C. Lint, *Soil Science*, vol. 2, no. 6, December, 1916.

"The Effect of Surface Film of Bordeaux Mixture on the Foliage Transpiring Power in Tomato Plants." J. W. Shive and W. H. Martin, *Plant World*, vol. 20, no. 3, March, 1917.

"Influence of Position of Grain on the Cob on the Growth of Maize Seedlings". Byron D. Halsted and Earl J. Owen. *Journal of the American Society of Agronomy*, vol. 9, no. 6, 1917.

"Environment of Seeds and Crop-Production". Byron D. Halsted and Earl J. Owen. *Plant World*, vol. 20, no. 9, September, 1917.

"Weight of Seeds as Related to Their Number and Position in the Pod, Soybeans". Byron D. Halsted. *Torreya*, vol. 17, no. 6, June, 1917.

"Degenerate Plants". Byron D. Halsted. *Journal of Heredity*, vol. 8, no. 6, June, 1917.

"Some Facts Relative to the Influence of Atmospheric Humidity on Insect Metabolism". T. J. Headlee. *Journal of Economic Entomology*, vol. 10, no. 4, February, 1917.

"Further Trial of Sulfur-Arsenate of Lead Dust Against the Strawberry Weevil". T. J. Headlee. *Journal of Economic Entomology*, vol. 10, no. 2, April, 1917.

"Some Recent Advances in Mosquito Work". T. J. Headlee and C. S. Beckwith. *Annals of the Entomological Society of America*, vol. 10, 1917.

"The Azalea Lace Bug, *Stephanits Pyrioides* Scott (Tingitidæ)". E. L. Dickerson and H. B. Weiss. *Entomological News*, vol. 38, no. 3, March, 1917.

"*Plagiodera Versicolora* Laich., an Imported Poplar and Willow Pest". H. B. Weiss and E. L. Dickerson. *Canadian Entomologist*, vol. 49, no. 3, March, 1917.

"The Bay Flea Louse, *Trioza Alaeris*, as a new pest in New Jersey". H. B. Weiss. *Canadian Entomologist*, vol. 49, no. 2, February, 1917.

"Some Unusual Orchid Insects (Hem., Lep., Dip., Col.)". H. B. Weiss. *Entomological News*, vol. 28, no. 1, January, 1917.

"Notes on Several Insects not Heretofore Recorded from New Jersey". H. B. Weiss. *Journal of Economic Entomology*, vol. 10, no. 1, February, 1917.

"The Ash Leaf Bug, *Neoborous Amoenus* Reut. (Hem.)". H. B. Weiss, and E. L. Dickerson. *Journal of the New York Entomological Society*, vol. 24, no. 4, December, 1916.

"A Soil Sampler for Bacteriological and Chemical Purposes". J. R. Neller. *Soil Science*, vol. 4, no. 2, August, 1917.

"Biological Changes in Soils During Storage". F. E. Allison. *Soil Science*, vol. 3, no. 1, January, 1917.

"A Review of Investigations in Soil Protozoa and Soil Sterilization". N. Kopeloff and D. A. Coleman. *Soil Science*, vol. 3, no. 3, March, 1917.

"The Influence of Fineness of Division of Pulverized Limestone on Crop Yield as well as the Chemical and Bacteriological Factors in Soil Fertility". N. Kopeloff. *Soil Science*, vol. 4, no. 1, July, 1917.

"Biological Variations in Soil Plots as shown by Different Methods of Sampling". F. E. Allison and D. A. Coleman. *Soil Science*, vol. 3, no. 6, June, 1917.

"Effect of Ammonium Sulfate on Soil Acidity". F. E. Allison and R. C. Cook. *Soil Science*, vol. 3, no. 6, June, 1917.

"The Effect of Soil Reaction on the Availability of Ammonium Sulfate". R. C. Cook and F. E. Allison. *Soil Science*, vol. 3, no. 5, May, 1917.

"The Effect of Sterilization of Soils by Heat and Antiseptics upon the Concentration of the Soil Solution". G. P. Koch. *Soil Science*, vol. 3, no. 6, June, 1917.

"Studies on Soil Colloids: II, Influence of Colloids on Electrical Conductivity of Salts". M. I. Wolkoff, *Soil Science*, vol. 3, no. 5, May, 1917.

"Absorption of Ammonium Sulfate by Soils and Quartz Sand". M. I. Wolkoff, *Soil Science*, vol. 3, no. 6, June, 1917.

"Influence of Bordeaux Mixture on the Rate of Transpiration from Abscised Leaves and from Potted Plants". W. H. Martin. *Journal of Agriculture Research*, vol. 7, no. 12, December, 1916.

"Scleotiarum Botaticola; The Cause of a Fruit Rot of Pepper". W. H. Martin. *Phytopathology*, vol. 7, no. 4, August, 1917.

"A Nectria Parasite on Norway Maple". Mel. T. Cook, *Phytopathology*, vol. 7, no. 4, August, 1917.

"Gardenia Studies". C. H. Connors. *Proceedings of Society for Horticultural Science*. 1916.

"A Purple Carnation". C. H. Connors. *Florists' Exchange.* December 30, 1916

"Splitting of the Calyxes of Carnations". C. H. Connors. *Florists' Exchange.* December 2, 1917.

"Methods of Work in Pruning Investigations for Peaches". C. H. Connors. *Proceedings of the Society for Horticultural Science,* 1916.

"The Yellowing of the Leaves of Gardenias". C. H. Connors. *Florists' Exchange.* January 20, 1917.

"The Analysis, Purification and Some Chemical Properties of Agar Agar". C. R. Fellers. *Journal of Industrial and Engineering Chemistry,* vol. 8, no. 12, December, 1916.

"Efficiency of Protein Carriers as Measured by Fecundity". H. R. Lewis. *Journal of the American Association of Instructors' and Investigators in Poultry Husbandry,* vol. 3, no. 4, January, 1917.

Popular Papers

"Soil Fermentation and the Feeding of Crops". J. G. Lipman. *Rural New Yorker,* October 28, 1916 to November 4, 1916.

"Helpful Bacteria on the Farm". J. G. Lipman. *Pennsylvania Farmer,* December 16, 1916.

"Some Harmful Bacteria on the Farm". J. G. Lipman. *Pennsylvania Farmer,* January 6, 1917.

"The Service Rendered to the Farmers of New Jersey by their Agricultural Experiment Station and College". J. G. Lipman. *Voorhees Farmer,* January, 1917.

"Employment of Research Assistants who may Register as Graduate Students in the College". J. G. Lipman. *Proceedings of the Association of Agricultural Colleges and Experiment Stations, 1916.*

"Agricultural Utilization of the Salt Marsh". J. G. Lipman. *Proceedings of the New Jersey Mosquito Extermination Association,* 1917.

"Agriculture's Debt to Science". J. G. Lipman. Proceedings of the Second Agricultural Convention. *New Jersey State Department of Agriculture,* Bulletin 5.

"Agricultural Conditions in New Jersey". J. G. Lipman. *New Jersey,* July, 1917.

"The Agricultural Utilization of the Salt Marsh". J. G. Lipman. *New Jersey,* May, 1917.

"The Food Situation". Alva Agee. *New Jersey,* July, 1917.

"Horticulture as a Science and as an Art". M. A. Blake. *Proceedings of Society for Horticultural Science,* 1916.

"Facts of Historic Interest". M. A. Blake. *Proceedings of New Jersey State Horticultural Society,* 1916.

"Practical and Scientific Points in Peach Growing". M. A. Blake. *Proceedings of New Jersey State Horticultural Society,* 1916.

"The Small Fruit Industry in New Jersey". M. A. Blake. *New Jersey,* May, 1917.

"The Canning Industry in New Jersey". M. A. Blake. *New Jersey,* July, 1917.

"Fruits for a Family Orchard". M. A. Blake. *Rural New Yorker,* November 8, 1916.

"Popular Varieties of Peaches about Hammonton, N. J.". M. A. Blake. *Voorhees Farmer,* April, 1917.

"Hiley Peaches Hard to Obtain". M. A. Blake. *Voorhees Farmer,* April, 1917.

"The Fruit Grower's Problem in 1917". M. A. Blake. *Voorhees Farmer,* May, 1917.

"The Progress of the Season". M. A. Blake. *Voorhees Farmer,* June, 1917.
"Spraying Experiments with Peaches". M. A. Blake. *Voorhees Farmer,* June, 1917.
"Why You Should Exhibit Fruit and Vegetables". M. A. Blake. *Voorhees Farmer,* September, 1917.
"Peaches Attacked by Brown Rot". M. A. Blake, *Voorhees Farmer,* July, 1917.
"Thinning the Peach Crop". M. A. Blake. *Voorhees Farmer,* July, 1917.
"Variation in Size of Fruit in Same Pack". M. A. Blake. *Voorhees Farmer,* August, 1917.
"Measurements of Soil Fertility". A. W. Blair. *Voorhees Farmer,* October, 1917.
"The American Farmer's Opportunity". A. W. Blair. *Hoard's Dairyman,* June 1, 1917.
"Report on New and Valuable Fruits". A. J. Farley. *Proceedings of the New Jersey State Horticultural Society,* 1916.
"Peace Leaf-Curl". A. J. Farley. *Voorhees Farmer,* April, 1917.
"Strawberry Variety Tests". A. J. Farley. *Voorhees Farmer,* May, 1917.
"Seasonable Hints on Spraying Fruit Trees". A. J. Farley, *Voorhees Farmer,* May, 1917.
"Equipping the Orchard". A. J. Farley. *The Field,* March, 1917.
"Orchard Tillage". A. J. Farley. *Country Gentleman,* May, 5, 1917.
"Fruit Packages Scarce". A. J. Farley. *Voorhees Farmer,* May, 1917.
Results of Summer Spraying and Dusting Peaches". *Proceedings of the American Pomological Society,* 1917.
"Peach Prospects". C. H. Connors. *Voorhees Farmer,* April, 1917.
"Some Future Varieties of Peaches". C. H. Connors. *Voorhees Farmer,* July, 1917.
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"Practical Suggestions for Alfalfa". Frank App. *Voorhees Farmer,* August, 1917.
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"Cold Frame Industry in New Jersey". R. W. De Baun. *Market Growers' Journal*, January 15, 1917.

"Fall Lettuce in New Jersey". R. W. De Baun. *Market Growers' Journal*, August, 1917.

"Growing Celery Seed in New Jersey". R. W. De Baun. *Market Growers' Journal*, April 15, 1917.

"Vegetable Growing Industry Around the Great Lakes". R. W. De Baun. *Ohio Farmer*, September 29, 1917.

"Horse Radish Propagation". R. W. De Baun. *Country Gentleman*, December 1, 1917.

"Renewing Rhubarb Roots". R. W. De Baun. *Country Gentleman*, December 1, 1917.

"Head Lettuce in the Fall". R. W. De Baun. *Country Gentleman*, July 21, 1917.

"Cabbage Worms in 1917". R. W. De Baun. *Country Gentleman*, July 21, 1917.

"Labor Saving Trowels". R. W. De Baun. *Country Gentleman*, May 12, 1917.

"The Useful Drag". R. W. De Baun, *Country Gentleman*, April 21, 1917.

"Disease-Resistant Seed". R. W. De Baun. *Country Gentleman*, March 3, 1917.

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REPORT OF THE
DEPARTMENT OF CHEMISTRY

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Report of the Department of Chemistry.

Charles S. Cathcart

I

INTRODUCTORY

The annual reports of the Department of Chemistry must be along the same lines each year since the activities of the department are very largely confined to the inspection work required by the laws regulating the sale of fertilizers, agricultural lime, feeding stuffs and insecticides. During the past year the required inspections have been made and the detailed results have been published in five bulletins. In addition to the inspection work, the department has cooperated with the other departments in so far as our services were requested and the time would permit.

The report of the activities for the fiscal year ending October 31 is divided into two parts; namely, administration and inspections.

II

ADMINISTRATION

The work required by the annual inspection was completed at the usual time, and this was due to the manner in which the members of the staff accepted the unusual conditions which were forced upon us during the year. On account of the great demand for chemists, several of the assistant chemists received offers of other positions in commercial work which seemed more attractive than the positions they were holding at the Station, and as a result several resignations were received. During the year six members of the staff resigned, four to accept positions in commercial work. One member of the staff returned to his college to continue his studies, and another member, D. James Kay, has been called for service in the army. At the present time our staff needs three

additional members in order to bring it up to the number necessary to care for the work usually entrusted to us.

The laws regulating the sale of fertilizers, agricultural lime, feeding stuffs and insecticides require annual registrations of the brands to be offered for sale, annual inspection of the materials found on the markets, and the publication of the results obtained. The fertilizer and feeding-stuffs laws do not permit the lowering of the standard of any distinct brand after it has been once registered and, consequently, it is necessary to refer to the previous registrations before a certificate can be issued. These two laws also require tonnage reports to be rendered twice a year. The printed forms for all of these requirements are supplied by the Station in order that they may be submitted in a form that can be filed for future reference. In order to secure the records required, it is hardly necessary to state that a considerable correspondence is necessary.

The following is a summary of the applications for registrations which were received and for which certificates were duly issued:

Fertilizer registrations	1640
Agricultural lime registrations	76
Feeding stuff registrations	2665
Insecticide registrations	194

During the inspections a total of 2232 samples was examined and reports were submitted to the manufacturers as well as to the parties whose stock was represented by the samples. The detailed results were also printed in the following bulletins:

Bulletin 304	Fertilizer Registrations for 1917.
Bulletin 311	Commercial Feeding Stuffs and Registrations for 1917.
Bulletin 314	Analyses of Commercial Fertilizers, Fertilizer Supplies and Home Mixtures.
Bulletin 315	Analyses of Materials Sold as Insecticides and Fungicides for 1917.
Bulletin 318	Analyses of Commercial Fertilizers and Ground Bone—Analyses of Agricultural Lime.

III

INSPECTION OF COMMERCIAL FERTILIZERS

During 1917

The detailed results of the fertilizer inspection were published in Bulletins 314 and 318.

The authority for making the annual inspection of the fertilizers sold, in this state is given in the law entitled "An Act Concerning Fertilizers," which was approved March 27, 1912. This law requires the manufacturers to register the various brands of materials which they desire to offer for sale. This registration consists of a certified statement of all of the information which will be attached to the materials when sold, and the inspection is for the purpose of ascertaining whether the materials have been properly branded and, also, whether the guarantees have been satisfied.

Registrations

The registrations are required to be made annually on November first, but the manufacturres are permitted to register new brands at any time during the year, provided this requirement is complied with prior to the actual sale.

Applications for the registration of 1640 brands of mixed fertilizer and fertilizer materials were received from 124 manufacturers, and the certificates were promptly issued. All of these registrations were not made, however, at the time prescribed by the law,, since our inspectors located 86 brands which were sold by 40 different manufacturers before they had been registered. This condition is about the same as noted during the past four years, and the cause should be investigated by the companies responsible. It is quite evident that the requirement is not wilfully neglected, as almost without exception the registrations are made as soon as attention has been called to the omission.

The law requires the publication of the registrations and it is the practice to issue a bulletin in January, giving all of the registrations received up to the date of the bulletin, and the registrations received later are published in the second fertilizer bulletin. The bulletin containing the registrations for 1917, is No. 304 and was issued on January 22.

Reports of Tonnage

In accordance with the law and also with the certified statements made at the time of registering the brands to be offered for sale, reports of the tonnage sold are required to be rendered on April first and November first of each year. Table 1 gives a summary of the reports received during the past five years.

Table 1

Summary of Reports of Tonnage

Year.		APRIL REPORTS Mixed Fertilizers. Tons.	APRIL REPORTS Fertilizer Materials. Tons.	NOVEMBER REPORTS Mixed Fertilizers. Tons.	NOVEMBER REPORTS Fertilizer Materials Tons.	Total for the year Tons.
1913	....	87,446.91	10,303.17	51,706.28	7,204.79	156.661.15
1914	....	78,768.27	8,735.62	69,223.26	8,686.99	155,414.14
1915	....	87,052.13	7,276.45	53,288.11	5,459.28	153,075.97
1916	....	61,368.88	9,032.68	52,328.81	7,069.70	129,800.07
1917	....	86,840.44	9,146.80	74,231.13	6,264.73	176,483.10

Wholesale Prices of the Essential Elements of Plant-Food for 1916

The wholesale prices of the unmixed or raw materials used in preparing the mixed fertilizers are quoted weekly in the trade journal, "The Oil Paint and Drug Reporter." In order to express the figures given as prices per pound of actual plant-food, which is the form adopted by the experiment stations of this country, the quotations have been recalculated and tabulated for the entire year

Table 2

Wholesale Cost, per Pouud, in New York.

MONTHS 1914.	OF NITROGEN IN FORM OF—			OF PHOSPHORIC ACID IN FORM OF—	
	Nitrate of soda	Sulphate of ammonia	Dried blood	Acid phosphate	
	Min.	Min.	Min.	Min.	Min.
	Cts.	Cts.	Cts.	Cts.	Cts.
January	21.70	18.88	20.46	4.00	4.25
February	22.81	18.66	19.43	4.00	4.25
March	22.81	18.29	19.13	4.00	4.25
April	21.70	17.56	17.61	4.00	4.25
May	20.23	17.41	16.09	4.00	4.25
June	19.74	17.13	16.77	4.00	4.25
July	19.78	16.68	17.33	3.95	4.26
August	19.30	17.38	19.28	3.75	4.25
September	18.95	18.35	20.04	3.75	4.26
October	18.51	19.61	21.01	3.76	4.26
November	18.71	20.49	23.50	3.75	4.25
December	19.91	21.10	24.44	3.75	4.25
Average, 1916	20.84	18.46	19.59	4.07	
Average, 1915	15.47	16.03	17.11	2.70	
Average, 1914	13.39	13.14	16.66	2.83	

(table 2). On account of the fact that the report of the Station is made on October 31 of each year, the prices that have been tabulated are for the year 1916.

The Trade Value of the Essential Elements of Plant-Food

It has been customary for many years to publish a schedule of trade values of the fertilizer ingredients as adopted by the representatives of the experiment stations of the New England states, New York and New Jersey. These values are determined by a study of both the wholesale and retail prices for the six months preceding March first.

There has always been a fluctuation from month to month in the prices of the various materials, but before last year the differences were not so great but that reasonable avrages could be established. Last year the conditions were so abnormal that it was impossible to secure reasonable averages and, consequently, no schedule of valuations was prepared. The condition for 1917 was the same as reported for 1916 and it was decided, at the annual conference of the experiment station representatives, to omit the schedule for the year 1917.

Inspection for 1917

The collection of the samples for this inspection was made by the two regular inspectors who have been connected with this department for several years. Every county in the state was visited and a total of 1,445 samples was received at the Station, all but a small percentage of which were collected by the official inspectors. The samples represented the stock of 545 dealers and consumers who were located in 221 cities and towns.

The samples analyzed during the year consisted of the following:

552 Samples of Commercial Fertilizers.
21 Samples of Commercial Fertilizers (Duplicates).
16 Samples of Home Mixtures.
6 Samples of Humus and Manures.
137 Samples of Fertilizer Materials.
47 Samples of Ground Bone.
181 Samples of Sundry Materials.

960 Samples Total.

Guaranteed and Actual Composition

All of the samples of mixed fertilizers, with one exception, were accompanied by guarantees at the time of shipment. There

were a few guarantees, however, which were not stated exactly as required by law. The sample that was not accompanied by a guarantee was a special mixture and it was accompanied by the formula used.

Table 3

Average Analysis of 256 Brands Guaranteed to Contain Nitrogen, Phosphoric Acid and Potash

	AVERAGE		
	Found %	%	Guaranteed %
Nitrogen, as nitrates	0.53		
" " ammonia salts	0.89		
" " water-soluble organic	0.41		
" " water-insoluble organic	0.80		
" total		2.63	2.59
Phosphoric acid, total	10.51		
" " insoluble	1.78		
" " available		8.73	8.41
Potash		1.83	1.80

The total number of brands of mixed fertilizers examined was 552, and of this number 296 did not carry a guarantee for potash.

The average analysis of the 256 brands guaranteed to contain nitrogen, phosphoric acid and potash, and the average guarantees are given in table 3.

Table 4

Average Analysis of 296 Brands Guaranteed to Contain Nitrogen and Phosphoric Acid

	AVERAGE		
	Found %	%	Guaranteed %
Nitrogen, as nitrates	0.75		
" " ammonia salts	0.83		
" " water-soluble organic	0.48		
" " water-insoluble organic	0.87		
" total		2.93	2.93
Phosphoric acid, total	11.46		
" " insoluble	1.92		
" " available		9.54	9.17

The average analysis of the 296 brands guaranteed to contain nitrogen and phosphoric acid and the average guarantees are given in table 4.

A survey of the preceding averages will show that the averages are satisfactory, but if the detailed analyses as shown in the bulletins are studied it will be found that 172 brands satisfied every guarantee, and in addition to this number 208 brands substantially satisfied the guarantees. The records also show that the remaining 172 brands, or 31 per cent, were deficient. There were 156 brands deficient in one element and 16 brands deficient in two elements.

In the guaranteed brands examined there were 1,360 deficiencies possible, and of this number 188, or 13.8 per cent, were found. There were 85 deficiences in the total nitrogen content; 88 deficiencies in phosphoric acid and 15 deficiencies in potash.

By comparing the record of this inspection with that of 1916, it is quite evident that there was an improvement in the materials sold this year, the percentage of deficiencies having dropped from 16.9 to 13.8 per cent. This condition is encouraging but not ideal. The purchaser of fertilizers during these abnormal times must watch very carefully the materials he secures, and he must insist upon receiving the total quantity of plant-food guaranteed, since only a comparatively small difference in composition means a difference in dollars in the money value. Inasmuch as the prices of all fertilizers will be very much higher in 1918 than they were during the present year, the necessity for following the above suggestion will be apparent.

Quality of the Plant Food

The law requires a guarantee of the total content of nitrogen. Since this element can be supplied by a variety of materials, some of which are high-grade while others are of low grade, it is therfore advisable to ascertain definitely what is sold under the guarantee of total nitrogen.

Of the total number of brands of mixed fertilizers examined, 311 contained a portion of the total nitrogen in the form of nitrate of soda, 304 contained nitrogen in the form of ammonia salts and 210 contained both of these available forms of nitrogen.

The value of the organic nitrogen depends upon its source or upon the method of treatment before it is used in a mixed fertilizer.

The water-soluble organic nitrogen is considered to be satisfactory as a plant-food. The information given in a statement of the *amount of insoluble organic-nitrogen, without any additional information*, does not give a correct idea as to its value. In order to obtain this information it is necessary to ascertain its activity.

All of the brands of mixed fertilizers were examined by use of the alkaline-permanganate method in order to determine the character or activity of the insoluble organic nitrogen. By the use of this method it was ascertained that 60 brands contained insoluble organic nitrogen that was of inferior grade; 28 of these brands, however, contained an excess of total nitrogen which partially offset the amount of inferior quality.

The amount of phosphoric acid that is soluble in water, the amount soluble in ammonium citrate and the amount that is insoluble are given in the detailed analyses. The water-soluble portion soon becomes insoluble in water after it is placed in the soil, but it is distributed somewhat more widely than the insoluble portions. The sum of the water-soluble portion and that soluble in ammonium citrate is called available phosphoric acid, and is considered to be in such forms as to be readily available to the growing crops. The value of the insoluble portion depends upon whether it is derived from bone or from phosphate rock. Experience has shown that the phospheric acid from bone is much more readily available than that of phosphate rock.

If the phosphoric acid is purchased on the basis of the available portion alone, the amount of insoluble phosphoric acid does not take an important place. In purchasing the ordinary commercial fertilizer it is better to give consideration to the amount that is available instead of depending upon the insoluble portion.

The potash as reported is water-soluble and is doubtless readily available.

Summary of the Results of the Inspection

The following tabulation gives the names and addresses of the manufacturers of mixed fertilizers whose brands have been examined this year, as well as a summary of the results obtained. In tabulating these results a deficiency of 0.20 per cent or less of nitrogen and 0.30 per cent or less of phosphoric acid or potash has been disregarded.

Table 5.

Summary of the Results Obtained With the Mixed Fertilizers Examined During the Inspection of 1917.

MANUFACTURER.	ADDRESS.	Number of brands received.	Number of samples examined.	Number of samples satisfied guarantees.	Number of samples substantially equal to guarantees.*	NUMBER OF SAMPLES DEFICIENT IN— Nitrogen.	Phosphoric acid.	Potash.	One element.	Two elements.	Three elements.
Acme Guano Co.	Baltimore, Md.	7	7	4	....	....	3	1	2	1	....
Active Chemical Co.	Camden, N. J.	1	1	1	....	....	....	....	....	....	....
American Agricultural Chemical Co.	New York City	70	70	24	34	9	4	....	11	1	....
American Fertilizing Co.	Baltimore, Md.	9	9	3	3	....	1	2	3	....	....
Armour Fertilizer Works	Baltimore, Md.	16	16	2	9	2	4	....	4	1	....
J. H. Baird & Son	Marlboro, N. J.	3	3	1	2	....	....	....	....	....	....
Baltimore Pulverizing Co.	Baltimore, Md.	3	3	....	1	....	2	....	2	....	....
Baugh & Sons Co.	Philadelphia, Pa.	27	28	10	11	3	4	....	7	....	....
The Berg Co.	Philadelphia, Pa.	2	2	2	....	....	....	....	....	....	....
Berger Bros.	Easton, Pa.	1	1	1	....	....	....	....	....	....	....
Bowker Fertilizer Co.	New York City	16	16	1	9	5	1	....	6	....	....
William M. Brown	Cedarville, N. J.	1	1	1	....	....	....	....	....	....	....
Burlington County Produce Sales Co.	Mt. Holly, N. J.	6	5	1	3	1	....	....	1	....	....
Burlington Supply Co.	Burlington, N. J.	4	4	1	1	2	....	....	2	....	....
Carter's Tested Seeds, Inc.	Boston, Mass.	1	1	....	1	....	....	....	....	....	....
Chamberlin & Barclay	Cranbury, N. J.	1	1	....	....	1	....	....	1	....	....
Coe-Mortimer Co.	New York City	12	12	4	2	2	3	2	5	1	....
J. S. Collins & Sons, Inc.	Moorestown, N. J.	2	2	....	2	....	....	....	....	....	....
Consumers Chemical Corporation	New York City	5	5	3	2	....	....	....	....	....	....
E. A. Corey	Worton, Md.	1	1	....	....	1	....	1	....	1	....
James G. Downward Co.	Coatesville, Pa.	2	2	....	1	....	1	....	1	....	....
Farmers' Co-operative Association	Trenton, N. J.	3	3	....	2	1	....	....	1	....	....
Fogg & Hires Co.	Salem, N. J.	2	3	....	....	1	2	....	3	....	....
Forman & Dilatush	Dayton, N. J.	1	1	....	1	....	....	....	....	....	....
Godfrey Co-operative Fert. and Chem. Co.	Newark, N. J.	12	13	3	2	6	4	1	5	3	....
Chas. A. Green	Philadelphia, Pa.	1	1	....	....	1	....	....	1	....	....

*Not over 0.2 per cent low in nitrogen, or 0.3 per cent low in phosphoric acid or potash.

Table 5 (continued).

Summary of the Results Obtained With the Mixed Fertilizers Examined During the Inspection of 1917.

MANUFACTURER.	ADDRESS.	Number of brands received.	Number of samples examined.	Number of samples satisfied guarantees.	Number of samples substantially equal to guarantees.*	NUMBER OF SAMPLES DEFICIENT IN— Nitrogen.	Phosphoric acid.	Potash.	One element.	Two elements.	Three elements.
Griffith & Boyd Co.	Baltimore, Md.	2	2	....	1	1	....	....	1	....	....
Thomas Y. Hackett	Daretown, N. J.	1	1	1	....	....	....	....	....	....	....
Hendrickson & Dilatush	Robbinsville, N. J.	9	9	6	2	1	1	....	....	1	....
Heritage & Bro.	Mullica Hill, N. J.	4	5	....	3	....	2	....	2	....	....
S. M. Hess & Bro., Inc.	Philadelphia, Pa.	11	11	4	6	1	....	....	1	....	....
Heuser & Vreeland	Matawan, N. J.	1	1	1	....	....	....	....	....	....	....
Hill Bros.	Flemington, N. J.	2	2	1	....	....	1	....	1	....	....
Thomas Hill	Flemington, N. J.	2	2	1	1	....	....	....	....	....	....
P. Hoffman & Bro.	Raubsville, Pa.	1	1	....	1	....	....	....	....	....	....
Hubbard Fertilizer Co.	Baltimore, Md.	2	2	....	1	....	1	....	1	....	....
H. H. Hutchinson, Jr.	Robbinsville, N. J.	5	5	....	2	3	1	....	2	1	....
International Seed Co.	Rochester, N. Y.	2	2	....	....	....	2	....	2	....	....
H. B. Kemp	Long Branch, N. J.	2	2	....	....	2	1	....	1	1	....
Keystone Bone Fertilizer Co.	Philadelphia, Pa.	6	6	2	2	1	1	....	2	....	....
William Lancaster	Philadelphia, Pa.	3	3	....	....	2	1	....	3	....	....
C. A. Lippincott & Bro.	Moorestown, N. J.	1	1	....	1	....	....	....	....	....	....
Listers Agricultural Chemical Works	Newark, N. J.	20	20	6	9	1	4	....	5	....	....
Locke & Black	Swedesboro, N. J.	5	5	2	2	1	....	....	1	....	....
Mapes, F. & P. Guano Co.	New York City	7	7	2	1	....	4	....	4	....	....
Martin Fertilizer Co.	Philadelphia, Pa.	10	10	1	1	2	6	....	8	....	....
Middlesex Fertilizer Co.	Plainfield, N. J.	1	1	....	1	....	....	....	....	....	....
Monmouth County Farmers' Exchange	Freehold, N. J.	3	4	2	2	....	....	....	....	....	....
I. R. Moore	Swedesboro, N. J.	7	7	3	2	1	1	....	2	....	....
Nassau Fertilizer Co.	New York City	7	7	2	5	....	....	....	....	....	....
Albert Nelson	Allentown, N. J.	8	8	2	5	1	....	....	1	....	....

N. J. Fertilizer & Chemical Co.	New York City	1	1	....	....	1	....	....	1	....	....
J. F. Noll & Co.	Newark, N. J.	2	2	....	....	....	2	....	2	....	....
Patapsco Guano Co.	Baltimore, Md.	4	4	1	1	1	1	....	2	....	....
Philadelphia Guano Works	Philadelphia, Pa.	3	3	1	....	....	2	....	2	....	....
Rasin-Monumental Co.	Baltimore, Md.	18	20	8	11	....	1	....	1	....	....
Reading Bone Fertilizer Co.	Reading, Pa.	3	3	3	....	....	....	....	....	....	....
Robert A. Richard	Allentown, Pa.	1	1	....	1	....	....	....	....	....	....
Ellwood Roberts Co.	Philadelphia, Pa.	4	4	1	1	1	2	....	1	1	....
F. S. Royster Guano Co.	Baltimore, Md.	14	16	5	10	....	....	1	1	....	....
Ruckman Bros.	New Brunswick, N. J.	2	2	....	2	....	....	....	....	....	....
Schanck, Hutchinson & Field	Hightstown, N. J.	3	3	1	2	....	....	....	....	....	....
Scott Fertilizer Co.	*Elktown, Md.*	5	5	1	2	2	1	....	1	1	....
Seaboard Utilization Co.	Long Branch, N. J.	1	1	1	....	....	....	....	....	....	....
M. L. Shoemaker & Co., Ltd.	Philadelphia, Pa.	2	3	3	....	....	....	....	....	....	....
Harry L. Sickel	Woodbury, N. J.	3	3	....	1	1	....	1	2	....	....
South Jersey Farmers' Exchange	Woodstown, N. J.	18	18	2	8	2	6	....	8	....	....
Standard Guano Co.	Baltimore, Md.	12	12	3	2	3	3	1	7	....	....
Standard Wholesale Phosphate Co.	Baltimore, Md.	1	1	....	1	....	....	....	....	....	....
Swift & Co.	Baltimore, Md.	9	9	2	1	2	5	1	4	2	....
Swift & Co.	Kearny, N. J.	21	21	5	7	4	4	2	8	1	....
Taylor Bros.	Camden, N. J.	1	1	1	....	....	....	....	....	....	....
I. P. Thomas & Son Co.	Philadelphia, Pa.	12	12	5	6	1	....	....	1	....	....
Trenton Bone Fertilizer Co.	Trenton, N. J.	12	12	6	3	3	....	....	3	....	....
F. W. Tunnell & Co., Inc.	Philadelphia, Pa.	24	34	10	8	11	4	1	16	....	....
J. E. Tygert Co.	Philadelphia, Pa.	7	7	1	4	2	....	....	2	....	....
Virginia-Carolina Chemical Co.	New York City	14	15	8	4	2	1	....	3	....	....
J. Wenderoth & Sons	Camden, N. J.	3	3	2	1	....	....	....	....	....	....
West Jersey Marl & Trans. Co.	Woodbury, N. J.	11	11	7	2	1	1	....	2	....	....
W. E. Whann Co.	Philadelphia, Pa.	2	2	2	....	....	....	....	....	....	....
William Wilde	Vineland, N. J.	1	1	....	....	....	1	....	1	....	....
Worthley & Holland, Inc.	Marlboro, N. J.	5	5	1	1	2	1	1	2	1	....
J. M. Wyckoff	Princeton Jct., N. J.	3	3	....	1	....	1	1	2	....	....

*Not over 0.2 per cent low in nitrogen, or 0.3 per cent low in phosphoric acid or potash.

IV

INSPECTION OF AGRICULTURAL LIME

The inspection of the products sold as agricultural lime was made in accordance with the law entitled "An Act to Regulate the Sale of Agricultural Lime." The essential features of this law, briefly stated, are:

1. Registration of the brands and the guarantees that will be attached to the materials as sold.

2. The constituents that must be guaranteed.

3. The name and address of the party responsible for the material.

4. The official inspection of the materials offered for sale.

Registrations

During the year 37 manufacturers registered 76 different brands of agricultural lime. The names and addresses of those who have registered their products are:

Acme Lime Co., Inc., Baltimore, Md.; American Agricultural Chemical Co., New York City; J. E Baker Co, York, Pa; S. W. Barrick & Sons, Woodsboro, Md.; Beaver Dam Marble Co., Cockeysville, Md.; Blair Limestone Co., Martinsburg, W. Va.; Carbo Agricultural Lime Co., Wilmington, Del.; F. E. Conley Lime & Fertilizer Co., Utica, N. Y.; Judson Conover, Matawan, N. J.; G. & W. H. Corson, Plymouth Meeting, Pa.; Edison Pulverized Limestone Co., New Village, N. J.; J. P. Exton, Clinton, N. J.; Fountain Rock Lime Co., Woodsboro, Md.; M. J. Grove Lime Co., Lime Kiln, Md.; International Agricultural Corporation, Buffalo, N. Y.; J. B. King & Co., New York City; Knickerbocker Lime Co., Philadelphia, Pa.; E. J. Lavino & Co., Philadelphia, Pa.; LeGore Combination Lime Co., LeGore, Md.; Weller C. Leigh, Lebanon, N. J.; Merion Lime and Stone Co., Morristown, Pa.; M. C. Mulligan & Son, Clinton, N. J.; E. J. Neighbour, German Valley, N. J.; Palmer Lime and Cement Co., New York City; Philadelphia Lime Co., Inc., Philadelphia, Pa.; C. T. Russell, Jersey City, N. J.; Security Cement and Lime Co., Hagerstown, Md.; Standard Lime and Stone Co., Baltimore, Md.; Standard Lime and Stone Co., Buckeystown, Md.; Steacy & Wilton Co., Wrightsville, Pa.; Benjamin Stoner, Hellam, Pa.; Tidewater Portland Cement Co., Baltimore, Md.; Todd & Cordes, Peapack, N. J.; Twining & Large Co., Carpenterville, N. J.; Vanderhoof Lime Co., Hamburg, N. J.; Charles Warner Co., Wilmington, Del.; Whitemarsh Lime Works, Philadelphia, Pa.

Inspection

Twenty-one samples of the various lime products were examined and the results are given in detail in Bulletin 318.

V

INSPECTION OF COMMERCIAL FEEDING STUFFS FOR 1917

The results of this inspection were reported in detail in Bulletin 311.

The law regulating the sale of commercial feeding stuffs in this state requires an annual inspection of the materials sold for the purpose of feeding live stock and poultry and, also, the publication of the results obtained.

The requirements of the law, Chapter 218, Session of 1912, which should be of particular value to the consumer, relate to the statements regarding the composition of the materials offered for sale. The sellers of every commercial feed are required to attach to the materials guarantees of the minimum content of protein, the minimum content of fat and the maximum content of fiber. The statement must also give the specific name of each ingredient used in preparing the feeding stuff. The object of this requirement is to inform the purchaser as to the claims for the material, but it does not necessarily follow that because a material is accompanied by these statements the purchase would be desirable or economical, since the law does not prohibit the use of any material unless it is injurious, nor does it regulate the proportionate amounts of the various ingredients used.

The statements have a decided value, however, since with the information given, the purchaser can determine whether the feed is desirable for his use and whether it is an economical feed when compared with other materials that are available, which is at the present time a very important consideration.

It is apparent that in order to purchase wisely it is necessary to be familiar with the composition and characteristics of the various feeding stuffs.

Composition of Feeding Stuffs

A feeding stuff is composed of groups of chemical compounds which have certain functions to perform in the production of energy and in maintaining or building up the animal body. The determination of the amounts of these groups constitutes the chemical analysis of a feeding stuff. The determinations of the amount of moisture, protein, fat and fiber generally give sufficient information

for one to pass judgment upon the value of the feed under examination, but if additional information is needed the determinations of nitrogen-free extract and ash are made. The groups of all of the chemical compounds may be described as follows:

MOISTURE in feeding stuffs is the water found in all grains and feeding stuffs, and the amount varies according to the kind of feeding stuff, its age and state of greenness and the method of storing.

PROTEIN is the nitrogenous constituent of a feed and is represented by such substances as the gluten of wheat, the albumen or white of an egg, the lean part of beef, etc. An analysis of pure protein will show that it contains about 16 per cent of the element nitrogen. The term "protein" as usually used simply means the total nitrogen content multiplied by the factor 6.25.

FAT, or more correctly called *ether-extract,* consists of the fat together with small quantities of wax, coloring matter and other substances that may be dissolved from a dried feed by anhydrous ether.

NITROGEN-FREE EXTRACT, sometimes call *carboyhydrates,* includes such materials as starch, sugars, etc.

FIBER, or crude fiber, is the structural material or woody part of the grains, hay or other feeding stuffs.

ASH is the mineral constituent of feeds and consists largely of phosphate of lime and potash.

Registrations

During the past year 485 manufacturers and jobbers registered 2,665 brands of feeding stuffs which they intended to offer for sale in this state. During the inspections 80 brands were found which had not been registered, and the parties responsible for the materials were immediately notified of the requirements of the law. In response to these notices 58 of the brands were registered and are included in the total number of registrations as statd above. New Jersey manufacturers were responsible for 19 of the 22 unregistered brands, and the records show that the total tonnage of all of the unregistered brands was very small. Inasmuch as the parties responsible for these brands are informed in regard to the penalties prescribed in the law for the sale of such materials, it is expected that registrations will be made before the materials reach the consumer.

Tonnage of Feeding Stuffs Sold

The law requires reports to be filed on July first and January first of each year showing the tonnage of feeding stuffs sold during the preceding six months.Table 6 is a summary of the reports received covering the sales made during the past four years.

Table 6

Summary of Tonnage of Feeding Stuffs Sold

Year	July Reports Tons	Jan. Reports Tons	Total for the year Tons
1913	93,664.17	102,560.00	196,224.17
1914	88,192.50	114,508.73	202,701.23
1915	103,626.91	124,563.34	228,190.25
1916	111,910.84	123,437.16	235,348.00

Inspections

During the inspections, 1,429 samples were received, 57 of which were forwarded by individuals and the others were collected by our regular inspectors. The inspections included every county in the state, and the samples were secured in 174 cities and towns and represented the stock of 318 dealers and consumers.

Examination

Every sample reported was examined by the use of the official methods as adopted by the Association of Official Agricultural Chemists in order to determine the content of protein, fat and fiber. They were also examined microscopically in order to determine the ingredients present.

Results of the Inspection

The total number of samples examined was 1,160, and of this number 1.103 samples were collected by our regular inspectors. Fifty-seven samples were forwarded by individuals and were reported directly to those requesting the analyses. During the examination of the official samples it was found that 356, or 32.3 per cent, did not satisfy the guarantees given for the content of protein, fat and fiber. The deficiencies found consisted of the following: protein, 110; fat, 103; and fiber, 216; 292 samples being deficient in one nutrient, 55 deficient in two nutrients and 9 deficient in the three nutrients.

Table 7 shows the percetage of deficiencies that has been found during the last four inspections.

Table 7

Deficiencies in Feeding Stuffs Inspected

Inspection	Samples examined.	Per cent of samples deficient	Per cent of samples deficient in		
			Protein.	Fat.	Fiber.
1914............	740	17.7	8.2	5.4	7.2
1915............	920	17.2	6.7	6.8	6.6
1916............	1102	26.6	9.3	9.3	14.0
1917............	1103	32.3	10.0	9.3	19.6

These figures show that of the four inspections compared, the inspection for 1915 gave the best results, when 17.2 per cent of the samples examined were deficient. This number of deficiencies is entirely too great, but it can hardly be expected, although it is possible, to have every sample fully satisfy the guarantees. The deficiencies for the present year are 32.3 per cent, or nearly twice as many as found in 1915. If the number of deficiencies in 1915 was too high, it must be admitted that the 1917 inspection presents a serious condition and one that should be given careful attention by all consumers of feeding stuffs.

When a feeding stuff is offered for sale the party responsible for the material guarantees to give a certain number of pounds of nutrients for the price stated. If the material does not contain the quantity of nutrients claimed, the purchaser has paid an excessive amount for his feed, the excess being in proportion to the shortage. These excess charges during the past year have undoubtedly amounted to a considerable sum of money. This condition should not exist. The purchaser should pay for the material he buys and he shoud get the full amount which was guaranteed to him.

In order to accomplish this the consumer who secures a shipment of a feeding stuff that is deficient should demand and collect a rebate which would be equivalent in value to the shortage found. If the deficient shipment is a part of the stock of a dealer, he should not sell it to his customers unless the party responsible for it had the guarantee changed according to its true composition, and if this is not done the material should be returned. If there is no other reason, the present high cost of feeding stuffs demands the consumer to watch very closely the character of the materials offered and the quantity of nutrients obtained.

Table 8

Summary of the Results of the Inspection

FEEDING STUFF.	Number of samples satisfied guarantees.	Average Composition.				Average retail selling price per ton.	Number of samples satisfied guarantees.	No. of samples deficient in					
		Moisture.	Protein.	Fiber.	Fat.			Protein.	Fat.	Fibre	One nutrient.	Three Nutrients.	Two nutrients.
		%	%	%	%	$							
Alfalfa Meal	20	7.99	15.60	1.66	27.04	32.50	12	1	2	2	3	1	..
Blood Meal	1	13.10	74.00	0.63	.....	.....	....	1	..	..	1	..	..
Buckwheat Feed	2	12.15	20.47	5.44	1.94	39.00	....	2	1	..	1	1	..
Brewers' Dried Grains	20	6.95	26.24	6.90	14.01	29.41	14	4	1	4	5	2	..
Buckwheat Middlings	12	12.12	30.85	8.01	3.28	34.00	9	1	..	1	2	..	..
Buckwheat Offal	10	10.32	18.17	4.53	16.74	25.50	5	2	2	4	1	2	1
Calf Meal	11	.....	.....	.....	.....	.....	5	4	2	..	6	..	..
Cocoanut Meal	2	7.01	21.28	10.75	9.63	33.00	2	..	..	..	..	..	..
Cottonseed Feed	1	8 23	38.13	6.59	10.95	.....	1	..	..	..	..	..	..
Cottonseed Meal	18	7.57	38.06	7.14	10.82	46.91	10	6	4	5	3	3	2
Corn Bran	4	8.48	10.71	6.60	6.91	30.00	2	..	2	..	2	..	..
Corn Feed Meal	16	11.56	8.86	3.90	2.44	40.33	11	1	1	4	3	..	1
Corn Gluten Feed	25	8.24	23.66	2.40	7.40	36.30	14	6	5	..	11	..	..
Corn Gluten Meal	1	9.25	43.81	0.96	2 71	.....	....	..	1	..	1	..	..
Corn Oil Cake Meal	1	9.08	19.13	9.98	9.10	34.00	1	..	..	..	..	..	..
Corn and Cob Meal	24	12.77	7.38	3.28	6.08	28.71	12	2	1	7	8	1	..
Corn and Oats	27	11.41	9.46	4.19	3.49	39.92	18	2	1	6	9	..	..
Distillers' Dried Grains—Corn	5	5.90	31.71	10.78	12.62	36.00	2	..	3	..	3	..	..
Distillers' Dried Grains—Rye	1	7.40	13.75	4.33	15.35	.....	....	..	1	..	1	..	..
Distillers' Dried Grains—Yeast	4	6.05	19.33	6.97	17.45	29.50	3	1	1	..	..	1	..
Distillers' Dried Grains—Continental Gluten Feed	1	8.07	28.75	9.69	8.23	.....	1	..	..	..	..	..	..
Distillers' Dried Grains—Mixed	1	7.12	20.63	7.89	16.62	.....	1	1	1	1	..	..	1
Dried Beet Pulp	3	8.72	8.98	0.70	19.09	37.00	3	..	..	..	..	..	..
Feeding Flour	12	9.74	16.78	4.78	3.27	41.30	12	..	..	..	..	..	..
Feed Mixtures	293	.....	.....	.....	.....	.....	174	19	29	89	91	23	..
Fish Scrap	1	7.26	55.69	0.99	.....	*2.90	....	..	1	..	1	..	..
Hominy Meal and Feed	12	8.98	10.88	7.06	4.70	40.40	11	..	1	..	1	..	..
Linseed Oil Meal	12	8.76	33.66	5.77	7.85	44.12	11	1	..	..	1	..	..
Malt Sprouts	6	7.57	25.15	0.93	12.11	32.00	3	2	3	1	1	1	1
Meat Scrap	26	6.01	50.18	13.97	.....	*2.90	13	11	5	..	10	3	..
Oat Feed (largely Oat Hulls)	2	6.59	5.92	1.67	27.47	24.00	....	..	2	2	..	2	..
Oat Hulls	1	7.70	5.06	1.41	30.45	22.00	....	..	..	1	1	..	..
Peanut Oil Meal	3	6.58	35.44	10.81	8.16	35.00	1	1	..	2	1	1	..
Poultry Bone	2	7.32	25.44	1.13	.....	.....	....	1	2	..	1	1	..
Poultry Foods	322	.....	.....	.....	.....	.....	233	25	21	36	64	6	2
Rye Bran	16	10.82	13.86	2.75	4.81	29.57	15	..	1	8	9	..	..
Rye Feed	4	11.56	12.99	2.35	3.01	33.00	2	..	..	1	1	..	..
Rye Middlings	20	11.68	12.76	2.59	3.09	35.31	10	..	..	9	9	..	..
Shredded Wheat Waste	1	7.38	9.88	1.58	2.11	.....	1	..	..	..	..	..	..
Star Feed	2	7.78	9.78	5.57	7.33	39.00	2	..	..	..	..	..	..
Vegetable Tankage	1	6.91	20.31	3.96	.....	.....	1	..	..	..	..	..	..
Wheat Bran	88	9.20	14.50	4.50	9.53	32.50	58	8	3	17	21	2	1
Wheat Feed	9	9.12	15.29	4.73	7.56	35.00	7	1	..	..	1	..	..
Wheat Middlings	82	9.91	15.55	4.63	5.11	38.47	53	7	6	15	18	5	..
Wheat and Rye Bran	1	10.17	14.50	2.84	5.96	29.00	....	..	..	1	1	..	..
Wheat and Rye Middlings	2	9.39	16.22	4.44	6.60	29.00	2	..	..	..	..	..	..
Wheat Middlings and Maizo Red Dog Flour	1	10.50	12.88	5.88	4.45	.....	1	..	..	..	..	..	..
Wheat Bran and Maizo Red Dog Flour	1	9.14	11.63	6.33	4.58	.....	1	..	..	..	..	..	..

*Average selling price per cwt.

A glance at the tabulation will show that the large increase in the deficiencies is due to the excess of fiber in many of the brands, and these increases mean a corresponding decrease in the carbohydrates.

It is difficult to explain the condition as found during this inspection, but the records show the condition as reported, and in order to profit by the experience, each consumer should insist upon getting the material he has to pay for.

Table 8 is a summary of the inspection, and gives the average composition of the various materials examined with the exception of calf meals, feed mixtures and poultry foods. It also gives the average selling prices of the feeds in so far as we were able to get them. The averages are not given for the three classes of feeds mentioned above because of the variable character of the different brands which are reported under their respective headings.

In preparing this tabulation the protein as found is considered to satisfy its guarantee if it is not more than 1 per cent below it. An allowance of ½ per cent also is made for the fat and the fiber determinations.

VI

ANALYSES OF MATERIALS SOLD AS INSECTICIDES AND FUNGICIDES FOR 1917

The law entitled "An Act to Regulate the Sale of Insecticides," Chapter 89, Session of 1912, requires an annual inspection of the insecticides sold in this state. In accordance with this requirement the inspection for the year 1917 was made and the results obtained were published in Bulletin 315.

Registrations

During the year 194 brands of materials were registered by the following manufacturers and jobbers:

Adler Color and Chemical Works, New York City; Allen Manufacturing Co., Quakertown, N. J.; Aphine Manufacturing Co., Madison, N. J.; E. J. Barry, New York City; James A. Blanchard Co., New York City; Boston Chemical Co., Boston, Mass.; Bowker Insecticide Co., Boston, Mass.; Cinnakol Chemical Sales Co., Bayonne, N. J.; Corona Chemical Co., Milwaukee, Wis.; Danforth Chemical Co., Leominster, Mass.; The Dow Chemical Co., Midland, Mich.; Felton, Sibley & Co., Inc., Philadelphia, Pa.; Samuel H. French & Co., Philadelphia, Pa.; Grasselli Chemical Co., Cleveland, O.; Hammond's Paint and Slug Shot Works, Beacon, N. Y.; Hemingway & Co., Inc., Bound Brook, N. J.; Morris Herrmann & Co., New York City; Interstate Chemical Co., Jersey City, N. J.; The Kil-Tone Co., Newark, N. J.; Fred L. Lavanburg,

New York City; Arthur Laver, Bernardsville, N. J.; Lebanon Chemical Co., Lebanon, Pa.; Leggett & Brother, New York City; Lehn & Fink, Inc., New York City; John Lucas & Co., Inc., Philadelphia, Pa.; McCormick & Co., Inc., Baltimore, Md.; Mechling Bros. Manufacturing Co., Camden, N. J.; A. Mendleson's Sons, Albany, N. Y.; Merrimac Chemical Co., Boston, Mass.; The Modoc Co., Inc., Fernwood, Pa.; Niagara Sprayer Co., Middleport, N. Y.; Nitrate Agencies Co., New York City; Pfeiffer Color Co., Inc., New York City; The Plantlife Co., New York City; Powers-Weightman-Rosengarten Co., Philadelphia, Pa.; B. G. Pratt Co., New York City; The Rex Company, Rochester, N. Y.; Riches, Piver & Co., Hoboken, N. J.; Schering & Glatz, New York City; Sherwin-Williams Co., Cleveland, O., and Newark, N. J.; Smith, Kline & French Co., Philadelphia, Pa.; H. J. Smith & Co., Utica, N. Y.; The H. A. Stoothoff Co., York, Pa.; Thomsen Chemical Co., Baltimore, Md.; Vreeland Chemical Co., Little Falls, N. J.

Inspection

During the inspection 105 samples were received at the Station, all but 5 of which were collected by one of the official samplers.

Ninety-one samples were examined, consisting of:

15 Samples of Paris Green.
31 Samples of Lead Arsenate.
8 Samples of Lime-sulphur
8 Samples of Bordeaux Mixture.
29 Samples of Miscellaneous Brands.

REPORT OF THE DEPARTMENT OF HORTICULTURE

Department of Horticulture

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**RALPH M. HUBBARD, B.SC., *Field Assistant.*

††DAVID SCHMIDT, B.SC., *Field Assistant.*

‡‡PAUL J. SASSI, *Field Assistant.*

***WILLIAM SCHIEFERSTEIN, *Orchard Foreman.*

†††ROBERT L. SCHARRING-HAUSEN, B.SC., *Field Assistant.*

*Died November 9, 1916.
†Appointed April 1, 1917.
**Resigned March 1, 1917.
††Resigned September 15, 1917.
‡Resigned October 31, 1917.
‡‡Resigned February 28, 1917.
***Appointed March 15, 1917.
†††Appointed September 15, 1917.

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Report of the Department of Horticulture

M. A. Blake

C. H. Connors

INTRODUCTION

The work of the horticultural department has been considerably disturbed during the past year. The florist, Mr. D. Manley Jobbins, died suddenly November 9, 1916, and the greenhouse investigations were greatly handicapped throughout the year. Mr. H. M. Biekart was employed as temporary florist beginning April 1, and the floricultural work is now proceeding normally again. Mr. Ralph M. Hubbard, Mr. Paul Sassi and Wm. S. Lewis resigned to enter commercial work, making it necessary to employ an entirely new organization for the care of the fruit plantings at the College Farm. Mr. W. Raymond Stone, orchard foreman at Vineland, resigned his position October 31 to accept a position with the Training School at Vineland. Mr. David Schmidt, who was in direct charge of some of the peach records, was called to the colors September 15, and was obliged to leave before the peach harvest was complete.

Extra labor for harvesting the peach crop was difficult to secure, but the yields and records were finally obtained.

At the beginning of the year the horticultural department attempted to reduce minor experiments and to arrange to concentrate upon the work is such a manner that the most valuable investigations might not be seriously affected by changes in staff and other difficulties.

The features of the work of the horticultural department for the past season were as follows:

1. There was a heavy yield of peaches from the peach-pruning experiments at Vineland, which is the fourth consecutive crop

since the trees were set in 1912. The season's results indicate that summer pruning of the tips of the branches in late June and early July delays the maturity of the fruit. This means that summer pruning prolongs vegetative action instead of checking it, as is commonly believed.

2. A good crop of peaches was harvested from the fertilizer plots at Vineland planted in 1907 and 1908.

3. Additional plantings of 1,070 seedling peaches from known parents were made at the Wolpert farm. Other pits secured from crosses during 1916 were planted in nursery rows.

4. A small quantity of fruit was secured from the trees in the standard apple pruning experiment at the College Farm. The trees were set in 1913.

5. The plant breeding work with carnations was continued by Mr. Connors and several seedlings producing purple flowers appeared.

6. The gardenia studies continued to yield important results. This plant offers exceptional opportunities for investigation.

7. An extensive spraying experiment with peaches was conducted by Mr. A. J. Farley in cooperation with Mr. Howard DeCou, of Moorestown. Self-boiled lime-sulfur, the sulfur-lime-glue mixture, and two forms of sulfur dust were compared as to their value in controlling peach scab.

8. Circular 63 describing a new summer spray for peaches was written by Mr. L. G. Gillam, and distributed in early spring. This spray was used by a large number of peach growers with general success.

9. Circular 64, describing the construction of a press for peach crates was prepared by Mr. H. C. Haines and the horticulturist.

10. Circular 83, "Pruning Experiments with Peaches" is a summary of a bulletin which will be published later when funds permit. The circular gives the results of the first two seasons' work. The authors are Mr. C. H. Connors and the horticulturist.

11. The variety and strain test with beets were continued and work done upon the vegetable area to prepare it for future experiments.

12. The weather observations were continued under the direction of Prof. A. J. Farley and Mr. William Schieferstein.

1917 AS A FRUIT SEASON

The fruit crops obtained during any certain season are often affected by the character of the preceding winter, and this was especially true in 1917 as far as peaches were concerned in New Jersey.

Beginning about the middle of November there was never a period of clear weather for three consecutive days until after the middle of February. The weather was not especially cold, but neither was it bright and warm because of the large proportion of cloudy, dull days which kept the buds in a perfectly dormant state. The buds in the experimental orchard at Vineland were less advanced at the beginning of growing weather than in any year since the orchards were planted in 1907.

The weather at the blooming time of peaches was not as favorable as in some years, and an attack of brown rot also in southern New Jersey destroyed many blooms and small fruits. These factors, however, did not reduce the crop in many orchards; in fact, they greatly reduced the necessity and expense of hand thinning.

Pears were only a medium crop in most orchards, but in some cases practically a full crop of Kieffers developed.

Apples produced only about 50 to 60 per cent of a crop as an average throughout the state. Some varieties produced full crops, as in the case of Baldwin in some orchards in Sussex County. Wealthy was another variety that yielded well in numerous instances. Rome in general produced only a partial crop.

BROWN ROT ON PEACHES

Following a most favorable winter, peaches in general throughout New Jersey bloomed freely and began to set a heavy crop of fruit. Suddenly brown rot began to develop upon the flowers and fruits in process of formation in central and southern New Jersey, destroying from 25 to 50 per cent of the blooms in some instances. Entire twigs also died outright in numerous cases, making the trees appear as though affected with some sort of a twig blight. Many growers failed to recognize the disease in this form and thought it a new disease. However, in the spring of 1907 an outbreak almost as severe occurred in southern New Jersey, as recorded by the

horticulturist in the station report for that year. A period of ten years, therefore, elapsed between the two severe outbreaks of this form of this disease.

Plate 1, figure 1, illustrates the appearance of a tree in May, 1917, after the brown rot had reached its height. Plate I, figure 2, shows several twigs that were affected by the early attack of the brown rot, resulting in the destruction of the flowers and the tips of the twigs.

Peach growers should be especially thorough in the summer spraying of their trees after such an outbreak; in fact, additional sprayings are generally advisable.

PEACH INVESTIGATIONS AT VINELAND

The peach experiments at Vineland passed a most successful season during 1917, and another good crop furnished data for the records.

The high percentage of cloudy days and the relatively cold weather during the winter months prevented the peach buds from starting prematurely, and a heavy set of bloom resulted. The weather continued cool after the growing season opened, and the trees made vegetative growth very slowly, which caused the fruits to develop rapidly. In May and June the green peaches on the trees were exceptionally large for the stage of development. During the latter part of June and early July, however, very favorable growing conditions prevailed, and the trees began to make a very fast growth. The green peaches immediately ceased their rapid development, as would be expected, and there was much complaint from growers throughout the state later that the fruit lacked size.

Peach scab developed freely on unsprayed trees in the Vineland district during 1917, and credit is due to Mr. W. Raymond Stone, orchard foreman, and Mr. David Schmidt for thorough spraying work in the station orchards, which kept the fruit practically free from scab and rot.

A Gifford fruit sizer was added to the equipment at the experiment orchards during the season, and while it sized round fruits quite successfully, it failed to do good work with fruits of an oval form.

Fig. 1.—Effect of Brown Rot upon the appearance of an affected tree.

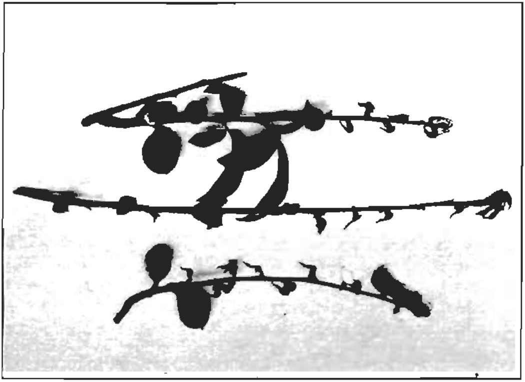


FIG. 2.—Twigs affected with Brown Rot.

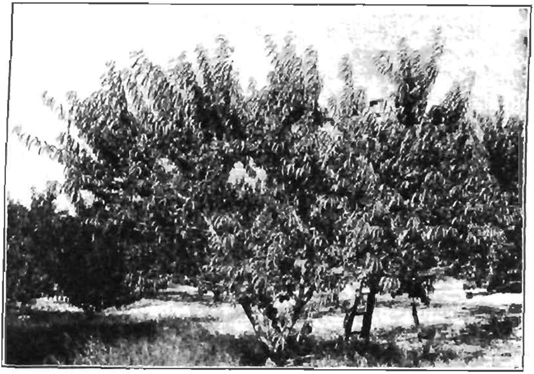


FIG. 1.—*A tree affected with both Little Peach and Yellows.*

FIG. 2.—Fruits from tree affected with both Little Peach and Yellows: *Left—Little Peach; Right—Yellows.*

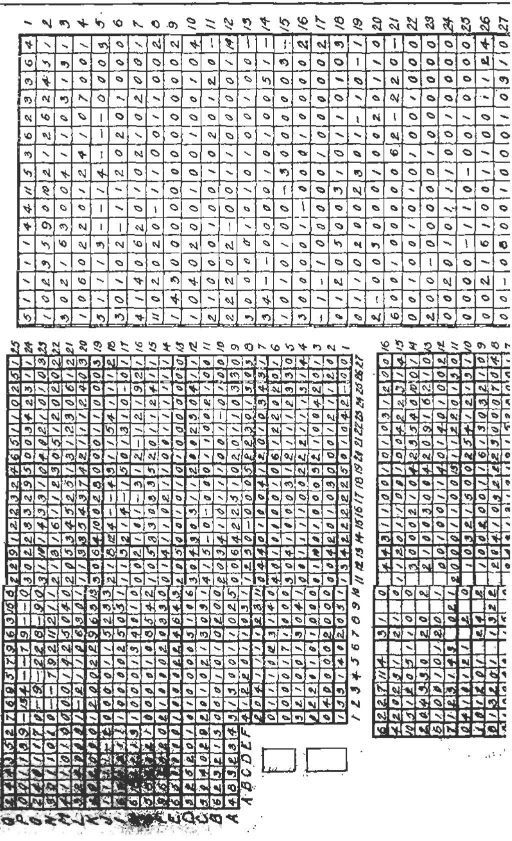
Orchard No. 1 at Vineland was set in 1907, and the fertilizer experiments have been continued over a period of 10 years. It is now the plan to publish the results as soon as funds permit, and to discontinue the fertilizer plots. The present condition of the fertilizer market makes it impossible to continue the experiments as originally planned, and 10 years is believed to be a sufficient period of time in which to judge the effect of the various treatments. It is now planned to treat Orchard No. 1 in a way to encourage maximum production and to demonstrate what may be accomplished with trees 10 years of age.

Peach Borer Observations at Vineland

As in previous years, a record was kept of the number of borers removed from each tree. Figure 1 shows a plan of the three orchards, each tree being represented by a rectangle, within which is indicated the number of borers removed from each tree. The character of the surroundings may be determined by referring to Diagram 1, opposite page 76, in the Annual Report of the New Jersey Agricultural Experiment Station for 1914.

The infestation by borers this year is apparently more general and more evenly distributed. The areas that have heretofore been most lightly infested, i. e., the southwest corner of Orchard No. 1, the center and western borders of Orchard No. 2, and the center of Orchard No. 3, still maintain that position, although infestation is gradually spreading. Table 1 is a record of the number of trees infested and the number of borers that have been removed from each row in Orchard No. 1 for the years 1913 to 1917, inclusive.

The infestation in this orchard has increased slightly over that of 1916, 7.6 per cent more trees being affected and 8 per cent more borers being found. However, the number of borers is less than half that found in 1915 and less than the number found in 1914. The highest percentage of infested trees was in row 13, with 25 out of 27. The greatest number of borers in any one row was found in No. 13, with a total of 118, with the next heaviest infestation in row 7. It is interesting to note that row 13 is a check row in a borer experiment, and has received no treatment to repel borers since the records began. This row was heavily infested in 1915 and 1916. Early in the experiment and during



PLAN OF ORCHARDS AT VINELAND, N. J.
SHOWING THE NUMBER OF BORERS REMOVED FROM EACH TREE IN 1917.

1913 and 1914 it was not so badly infested in proportion to a number of other rows. Row 7, which shows a very heavy infestation in comparison with 6 and 8, received a treatment of white lead each year from 1913 to 1915 and then nothing during 1916. All the rows in Orchard No. 1 except 1, 7, 13, 19, 25 and 27 received a spraying of whitewash and lime sulfur each year from 1913 to 1915 after the removal of the borers.

Table 1

Record of Borers Found in Orchard No. 1

May, 1913; May, 1914; May, 1915; May, 1916; May, 1917

Row.	1913.		1914.		1915.		1916.		1917.	
	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.
1	18	35	13	41	23	163	18	48	12	29
2	13	24	15	51	24	156	18	51	12	39
3	12	26	16	54	20	85	18	51	12	29
4	11	22	18	72	25	222	12	28	9	20
5	7	26	18	51	23	200	12	26	15	39
6	16	55	23	115	24	224	23	135	19	59
7	17	42	21	63	24	172	25	106	28	108
8	11	18	23	94	24	200	7	9	12	36
9	16	41	19	92	19	89	20	54	18	76
10	13	31	17	54	22	109	9	13	15	56
11	20	36	21	45	23	113	11	16	18	40
12	11	22	21	77	22	124	10	23	12	19
13	12	23	18	50	24	254	24	113	25	118
14	13	32	13	29	18	70	19	53	19	51
15	8	10	11	31	15	41	13	31	17	51
16	9	14	11	32	18	68	13	36	14	33
17	13	34	13	38	15	74	17	42	13	30
18	11	18	15	47	21	87	14	34	21	63
19	15	29	12	21	16	53	10	22	18	52
20	6	14	15	36	17	73	11	21	16	40
21	10	12	15	31	17	41	17	26	13	23
22	13	23	12	29	12	25	14	26	31	35
23	9	17	17	31	9	21	10	15	19	36
24	8	18	12	37	11	28	9	10	14	26
25	10	12	19	57	16	52	21	93	21	60
26	6	16	9	22	9	14	16	19	13	25
27	16	53	7	11	11	31	18	42	18	32
Total	326	693	423	1,311	502	2,789	409	1,140	440	1,231

Note—Each row contains 25 trees.

At the beginning of the experiments, the check row, no. 13, was not any more heavily infested than some of the treated rows, but it is now interesting to note that treatments were apparently of more value than the immediate results indicated. As has been

pointed out in previous reports trees whose trunks are badly scarred by wounds made by borers or in other ways are especially susceptible to borer attack, while trees which present an unbroken bark near the surface of the ground are much less likely to become affected.

Table 2

Record of Borers Found in Orchard No. 2
May, 1913; May, 1914; May, 1915; May, 1916; May, 1917

Row.	1913.		1914.		1915.		1916.		1917.	
	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.
1	16	20	15	70	15	117	15	130	13	60
2	16	10	12	51	7	22	11	35	9	18
3	11	15	10	22	10	28	10	32	9	23
4	8	14	13	46	6	20	14	47	11	29
5	6	18	11	90	9	22	14	50	9	28
6	6	8	18	36	15	35	10	27	9	20
7	11	22	9	27	9	12	13	32	..	..
8	7	12	12	31	12	57	13	43	..	..
9	3	44	12	20	7	12	13	31	9	19
10	4	7	11	25	7	9	12	28	..	..
11	4	4	10	33	11	24	14	25	6	11
12	3	4	7	12	11	23	7	14	..	..
13	4	7	8	18	7	12	12	36	11	22
14	6	8	14	27	11	20	9	14	8	20
15	7	11	9	16	3	3	10	14	9	25
16	4	8	7	14	3	4	5	6	8	10
17	6	7	9	12	9	14	12	24	10	18
18	4	4	5	8	4	6	7	13	8	16
19	5	5	7	8	4	6	6	10	9	15
20	10	25	12	39	11	27	11	32	15	53
21	4	10	11	21	13	34	9	18	12	28
22	4	6	7	15	11	20	15	22	11	22
23	6	11	12	24	9	16	13	37	12	45
24	4	7	8	12	8	15	15	42	10	21
25	5	8	10	16	6	11	12	26	12	58
26	12	22	8	23	14	35	16	40	9	29
27	6	12	7	23	7	20	9	29	10	25
28	4	18	11	66	5	12	11	34	10	28
Total.	186	342	280	766	244	686	316	893	..	..
*Total	161	297	241	561	205	535	271	775	239	523

The infestation in Orchard No. 2 shows a decrease from the infestation of 1916, as illustrated in table 2. Unfortunately, the record of the first worming of rows no. 7, 8, 10, and 12, was lost,

*The results from Rows 7, 8, 10 and 12 are excluded for each year to make the comparison uniform.
Note—Each row contains 16 trees.

hence these rows cannot be considered, and a separate total showing the annual totals with these rows removed is appended to the table. However, considering the rows for which complete data have been obtained, we find a reduction in the number of trees infested of 11.8 per cent; and, a reduction in the total number of borers found of 19.6 per cent over the results of the inspection of 1916. No single row had every tree inhabited by borers in this orchard.

A considerable decrease is seen both in the number of trees infested and in the number of borers found in Orchard No. 3, as

Table 3

Record of Borers Found in Orchard No. 3

May, 1913; May, 1914; May, 1915; May, 1916; May, 1917

Row.	1913.		1914.		1915.		1916.		1917.	
	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.	No. trees infested.	No. borers found.
1	8	14	9	28	20	56	22	75	22	66
2	9	11	10	13	22	50	17	52	10	17
3	17	25	21	54	27	187	28	106	19	40
4	11	14	8	12	13	28	9	30	9	15
5	14	21	18	35	23	90	27	87	19	59
6	8	11	14	29	13	28	18	87	13	29
7	5	5	3	5	9	16	11	18	7	10
8	1	3	10	18	23	65	17	52	16	43
9	3	3	7	11	11	29	14	34	19	38
10	6	12	8	10	11	19	15	47	14	37
11	6	6	4	7	11	22	16	43	15	27
12	6	10	11	34	13	28	12	45	10	23
13	3	3	8	9	14	17	20	39	15	30
14	6	8	6	17	14	27	10	50	13	31
15	5	8	9	12	19	48	19	45	11	25
16	7	11	9	25	10	18	15	65	16	46
Total .	116	166	155	319	253	727	270	875	228	536

Note—Each row contains 31 trees.

show in table 3. The number of trees infested was 15.6 per cent less than in 1916; and the number of borers found, 38.7 per cent less.

Only three rows, no. 9, 14, 16, had a greater number of trees infested, but of these only row 9 had more borers. Rows 14 and

16 had fewer borers in 1917; rows 1 and 4 had the same number of trees infested as in 1916, but the number of borers found was fewer in both cases.

An interesting condition is found in this orchard. When the trees were planted, rows 2, 4 and 7 were set in holes made with dynamite. These rows had the lowest percentage of trees infested and in the number of borers found in 1917. In fact, since 1913, there has been a noticeable difference in the percentage of trees infested and in the number of borers found in favor of the trees planted where dynamite was used over those planted by the usual method in adjoining rows, except in the case of the number of infested trees in row 7 and row 8 in 1913. Row 1, which is the outside row, was also an exception in 1913, 1914 and 1915. The trees planted by the use of dynamite made a much more rapid average growth during the first few years, and it is possible that they presented a more unbroken surface of bark, which in our experience would tend to make them resistant to borer attack.

No experiments with repellents were attempted this year. However, some further tests were made with sodium cyanide in solution applied to the soil about the roots of the tree, in order to determine the maximum strength of the solution that might be used.

Peach Yellows and Little Peach at Vineland

In 1916 a considerable number of peach trees developed advanced symptoms of little peach and yellows in New Jersey, and the outbreak continued to be rather severe during 1917. The loss in the experimental orchards at Vineland for 1916 was relatively light, but this has been followed by a large increase in the number of trees removed because of these two diseases in 1917, amounting to 98 trees, or 5.7 per cent of the aggregate. This infestation probably took place in 1916, since the observations at this Station indicate that it requires several months for what may be termed the "incubation" period.

A record of the diseased trees removed from Orchard No. 1 annually since 1909 appears in table 4.

Orchard No. 1 originally contained 675 trees. The total loss up to 1917 had been 47 trees, or 6.96 per cent. In 1917, 24 trees became diseased, a little more than half the total for the preceding

eight years. During this year, it will be noted that no trees in this orchard were removed because of yellows. A list of the diseased trees follows:

Row 5 tree 11; row 7 tree 4; row 14 tree 9; row 15 tree 14; row 15 tree 22; row 17 trees 14 and 15; row 18 trees 15 and 16; row 19 tree 25; row 20 tree 17; row 21 trees 17, 18, 22, 23 and 24; row 22 trees 19, 20, 21, 22, 23 and 24; row 24 tree 25; row 25 tree 25.

Table 4

Number of Trees Lost Because of Disease in Orchard No. 1

Year.	Yellows.	Little Peach.	Not Determined.*	Per cent Lost.
1909	..	..	2	0.3
1910	..	4	..	0.6
1911	5	..	..	0.7
1912	1	4	..	0.7
1913	8	3	..	1.6
1914	1	5	..	0.9
1915	1	3	..	0.6
1916	8	2	..	1.5
1917	..	24	..	3.6
Totals	24	45	2	
Grand Total		71	..	10.52

*In the early stages of these diseases in young trees it is difficult to distinguish between yellows and little peach.

Table 5

Number of Trees Lost Because of Disease in Orchard No. 2, Including A, B and C Plots

Year.	Yellows.	Little Peach.	Per cent Lost.
1911	3	4	1.27
1912	5	4	1.64
1913	3	10	2.36
1914	4	14	3.28
1915	1	20	3.82
1916	1	5	1.09
1917	13	23	6.54
Total	30	80	
Grand Totals	110		20.00

A diagram of the orchard was published in the annual report of this Station for 1915, and by referring to this diagram, the location of the trees that were removed may be determined. There were very few trees removed from positions isolated from previous in-

festations. Row 19, trees 25, and row 16, tree 22 were 4 trees distant from trees that had been diseased previously. A chain of diseased trees was taken out which connects two previously diseased areas.

The areas included in Plot 10, which lies between rows 13 and 19, and trees 13 and 19 in rows 14 to 18, inclusive, lost 5 trees from little peach. The first tree was removed from this plot in 1909 and others in 1910, 1913 and 1916. Most of those previously removed had been diseased with yellows, but those removed in 1917 had been diseased with little peach. This leads still further toward the suggestion that the cause of these diseases may be identical.

Table 5 shows that annual loss of trees from Orchard No. 2.

Orchard No. 2, including the A, B and C Plots, contains 550 trees. A loss of 110 trees means that one-fifth of the trees originally planted have been removed because diseased with either yellows or little peach. The loss in 1917 is the greatest for any one year.

The trees which were removed in 1917 are as follows:

LITTLE PEACH. Row 1 trees 2, 3 and 4; row 2 tree 16; row 4 trees 7, 8 and 16; row 5 trees 7 and 8; row 7 trees 8 and 9; row 11 tree 8; row 23 trees 4 and 5; row 24 trees 3 and 4; row 25 trees 4 and 16; row 27 trees 2, 3 and 11; row 28 tree 9; row A tree P.

YELLOWS. Row 13 trees 14 and 15; row 15 trees 14 and 15; row 16 tree 14; row 17 tree 14; row 18 tree 13; row A trees F, G and M; row B trees N and D; row C tree N.

Again referring to the diagram in the report for 1915 it will be noted that all diseased trees are adjacent to trees that have been removed in previous years, except the group affected by yellows in Plots 18 and 19, and this is separated by only one or two trees from the space formerly occupied by a tree diseased with yellows.

In previous years in this orchard, the great majority of the trees have been diseased with little peach, but in this year about one-third were diseased with wellows. It should be noted that the disease continues to spread in the northwestern and southwestern corners of this orchard.

Table 6 gives the annual loss from Orchard No. 3.

The loss for this year in Orchard No. 3, which contains 496 trees, is larger both in the number of trees and in the per cent lost. The total loss for the four years is 10.08 per cent, as compared with 5.14 per cent in both the other orchards in the first four years.

Table 6

Number of Trees Lost Because of Disease in Orchard No. 3

Year.	Yellows.	Little Peach.	Per cent Lost.
1914	1	..	0.2
1915	2	1	0.6
1916	4	4	1.6
1917	3	35	7.7
Totals	10	40	...
Grand total	50		10.08

The following trees were removed from Orchard No. 3 in 1917 because of disease:

LITTLE PEACH. Row 3 tree 2; row 5 trees 2 and 4; row 6 tree 2; row 7 tree 4; row 9 tree 4; row 10 trees 4, 8 and 15; row 11 tree 9; row 12 tree 11; row 13 tree 9; row 14 trees 2 and 9; row 17 tree 12; row 18 tree 11; row 19 tree 13; row 20 trees 11, 12, 13 and 14; row 21 trees 11 and 13; row 22 trees 12, 13 and 16; row 23 tree 6; row 24 tree 10; row 25 tree 12; row 28 tree 15; row 30 trees 4 and 16; row 31 trees 8, 9 and 16.

YELLOWS. Row 3 tree 8; row 10 trees 5 and 7.

In addition to the above, row 31 tree 14 became diseased, but it was permitted to remain for further study. This tree, shown in plate 2, figure 1, had one branch affected with yellows and another affected with little peach. Buds from these parts were taken and inserted in healthy trees at New Brunswick for further observation. Fruits from this tree are shown in plate 2, figure 2. The fruits on the left are from a branch diseased with little peach; and those on the right are from a branch affected with yellows, showing the premature ripening and the characteristic red spots in the flesh.

Referring again to the diagram in the report for 1915, it will be noted that most of the trees diseased in this orchard were isolated from trees diseased in previous years. The southwest corner, how-

ever, shows an increase in the number of trees removed, and there appeared to be a considerable center of infestation from rows 17 to 22, trees 11 to 14, inclusive.

The observation previously made, that no tree has yet become diseased that has been planted in the spot whence a diseased tree has been removed, still hold true. The trees replanted in the earlier years are now in bearing so that these annual losses are less severe than would be the case where no replanting was done.

The immediate removal of any tree as soon as the first symptoms of the disease are apparent is still most strongly advised. In the experimental orchards, where a diseased tree has been permitted to remain for a year or two for the purpose of study, the disease has continued to spread to nearby trees.

BREEDING WORK WITH PEACHES

Although no actual breeding of peaches has been done during the past year, satisfactory progress can be reported in this work. The seedling trees that were set in the spring of 1916 made a very vigorous growth, with but few losses, these being due to weakness of the trees at the time of planting. The growth of the trees having Belle as one of the parents has been notably good, especially the trees from the Belle-Greensboro cross.

A survey and study of the foliage of the trees in this planting was made in the late summer, with a view to predicting the color of the flesh of the fruit. It was found that some of the trees had set many flower buds and probably will produce blossoms and fruit next spring. Judging by the color of the foliage, the color of the fruit of the trees of the various crosses will be as follows:

	Number Probable Yellow	Number Probable White	Number Doubtful Yellow	Number Doubtful White
Belle, s. p.	25	61	11	29
Belle x Greensboro	..	61	1	..
Belle x Elberta	18	24	8	13
Belle x Early Crawford	14	10	4	5
Elberta, s. p.	6	..	..	..
Elberta x Greensboro	..	3	1	2
Elberta x Belle	2	2	1	2
Elberta x Early Crawford	18	..	2	6
Late Crawford, o. p.	34	13	12	11
Early Crawford, o. p.	28	..	6	1
St. John, o. p.	77	7	7	9

A further planting was made in the spring of 1917 of trees from pits secured by crossing in 1915 and sown in the nursery in the spring of 1916. These include the following:

Elberta, s. p.	139	Early Crawford x Belle	28
Elberta x Early Chawford	55	Early Crawford x Elberta	42
Elberta x Belle	92	Early Crawford x Greensboro	39
Elberta x Greensboro	113	St. John x Early Wheeler	54
Belle, s. p.	151	St. John x Greensboro	22
Belle x Elberta	9	St. John, o. p.	11
Belle x Early Crawford	97	Elberta sport, o. p.	36
Belle x Greensboro	159		
Early Crawford, s. p.	70	Total	1117

Most of these have made a satisfactory growth, considering the condition of the soil in which they were planted, and the site. The site was partly on a gravelly slope, running off to bare shale and the soil was in a rather poor state of cultivation. Only forty-four have been lost, even though a large number were not very vigorous when planted.

The crosses made in the spring of 1916 were with the early peaches, mainly yellow, but several white varieties were used. The pits were stratified and planted in the nursery last spring. The trees resulting from these crosses will be set in orchard form in the spring of 1918. A list of the crosses and the number of seedlings of each follows:

Lola, s. p.	86	Slappey x Arp	31
Lola x Arp	52	Slappey x Dewey	37
Lola x Early Crawford	67	Early Crawford x Arp	9
Lola x Slappey	39	Early Crawford, s. p.	26
Carman, s. p.	20	Early Crawford x Slappey	28
Carman x Slappey	4	Early Crawford x Dewey	6
Slappey, s. p.	12		
Slappey x Early Crawford	7	Total	424

Dewey is the earliest yellow freestone peach that we have, and it has the desirable quality of being very hardy in bud and slow to start into growth during warm periods in winter. However, it is not a good shipping peach, has too much "fuzz," is too dark in color and susceptible to rot. Slappey is the next earliest yellow freestone, but it lacks quality. Early Crawford, ripening after Slappey, is of the highest quality but lacks hardiness of bud and shipping quality. Arp (Beauty) is the earliest yellow peach ripening at the experimental orchards, and is a cling-stone. It

is of good quality for the season, but requires severe thinning to reach good size and is not bright enough in color. Carman is a well known, early white semi-cling and Lola is the earliest commercial white freestone.

The Dewey tree from which the pollen for crossing was taken became diseased with little peach later in the season. It will be interesting to note if the seedlings from this pollen will be diseased. No indications of disease in the seedlings are yet apparent.

Adjoining the orchard of seedlings that was planted in 1916, during the past spring a small orchard was set out containing a number of standard varieties of peaches that have been used in this breeding work and also a few standard varieties for comparison. In addition, a number of seedlings from earlier work that have proved of merit and several promising seedlings from other sources have been included in this planting. The varieties planted are as follows: White-Early Wheeler, Greensboro, Carman, Lola, Hiley, Belle, Heath Cling, Iron Mountain, Yellow-Arp, Dewey, St. John, Slappey, Early Crawford, Foster, Elberta, J. H. Hale, Late Crawford, Krummel (October). Others that have been planted are Pearson and B. G. Pratt, two late white seedlings, a new nectarine seedling, and eleven seedlings from Lola that have fruited for several years on the College Farm and have given promise of having merit.

FLORICULTURAL INVESTIGATIONS

The death of Mr. Jobbins greatly handicapped the floricultural work during the winter of 1916-1917, and when Mr. Biekart was finally secured to take his place it seemed best to undertake a limited number of experiments during 1917-1918.

Mr. L. A. Ruzicka continued his work with the American Beauty rose and some new features of culture are being tried.

Mr. H. M. Biekart is comparing two methods of training and pruning four varieties of roses.

The following varieties of roses are being grown in the station houses this season, My Maryland, Killarney Brilliant, Sunburst, Jonkheer J. L. Mock, Mrs. George Shawyer, Hadley, Ophelia, White Killarney and American Beauty.

The lime, soil and type of bench studies with carnations are being continued and the following varieties are under test: Pink En-

chantress, White Enchantress, Rose Pink Enchantress, Enchantress Supreme, Princess Dagmar, Matchless, White Perfection, Belle Washburn, Alice, Merry Christmas, Aviator, Thenanthos, Prosperity, Yellowstone and Yellow Prince.

Carnation Breeding

The breeding work with carnations is being continued by Mr. Connors with promise of success from a commercial standpoint. No seedlings were raised from seed during the year, but a large number of promising seedlings (69) are being propagated and grown for further test. Among these are:

COMMERCIAL.	Red, 18; white, 3; white and purple, 1; white and red, 1; white and pink, 2; red mixed with yellow, 6; deep pink, 1; yellow, 1; maroon, 3; purple, 4.
SINGLE.	Red, 17; yellow and red mixed, 6; maroon, 1; purple, 1; white, 1; dark pink, 1.
BULLHEAD.	Red, 1.

Some of these are being tested for their value as commercial varieties, and all are to be used together with a number of commercial varieties for the study of inheritance of color, vigor and other characters.

Worthy of note are the purple seedlings. While purple garden pinks are known, no satisfactory variety of the commercial type of carnation has been introduced. All that have been disseminated have been "bullheads" or "bursters," i. e., the calyx has split. The seedlings secured last winter at this Station are of very good form, and if they continue to be as satisfactory in growth as in the first year, they may prove a valuable addition to the list of commercial varieties of carnations.

Several of the red sedlings and one red and white variegated also are very promising.

GRAPE PLANTING

In view of the added facilities for fruit production provided by the acquisition of the Wolpert Farm, the establishment of a vine-

yard was started in May, 1917, by the planting of the following varieties: Concord, 80 plants, Brighton, 40 plants, Niagara and Diamond, 20 plants each, and 5 plants each of Agawam, Barry, Brilliant, Campbell's Early, Catawba, Duchess, Delaware, Empire State, Eumelan, Green Mountain, Iona, Ives, Salem, Moore's Early, Vergennes, Wilder. The comparatively large number of plants of the well known standard varieties will make it possible to test out various systems of training as well as provide ample material for numerous other tests that may be desirable as the occasion arises. Additional varieties of merit will be planted from time to time in order that observations may be made of all that show any promise when grown in the central part of New Jersey.

NEW PLANTING OF APPLES

Approximately four acres at the Wolpert Farm were planted to apples in the spring of 1916. The following varieties are included in this block: Grimes, Williams, Gravenstein, McIntosh, Delicious, Wagener, Baldwin, Livland (Raspberry), Paragon, Wealthy and Stayman. The Grimes, Wealthy, Wagener and Livland (Raspberry) as well as a portion of the McIntosh are planted as fillers in the centers of 40-foot squares formed by the other varieties planted as permanents.

WORK WITH VEGETABLES

In May, 1916, a farm of about 38 acres, which is known at the present time as the Wolpert Farm, was purchased by the Trustees of Rutgers College for the purpose of giving practical instruction to students in vegetable and fruit growing. During the past season 10 to 12 acres of vegetables have been grown on a commercial scale. Thirty-five strains of Earliana tomatoes were grown this summer. The seed was collected by Mr. R. W. DeBaun, extension specialist in market gardening, from tomato growers in Gloucester County. The data obtained from this work need further study.

Work was started in co-operation with Dr. T. J. Headlee to control the corn ear worm by means of dusting the "silks" of the ears with powdered arsenate of lead and ground sulfur, but the worms were not present in sufficient numbers to make the tests of much value.

The efficiency of tar paper discs and a mixture of gas house tar and sand (1 to 26) were compared in the control of the cabbage maggot on the early cabbage. This insect also appeared in too limited numbers to make the results reliable. It was found, however, that two applications of tar and sand could be applied in much less time and at a smaller cost than is required for the tar discs. It was noticed that burning resulted when the tar and sand was carelessly applied and some of the mixture remained upon the growing points of the plants.

The work on strains of beets which was started in the spring of 1914 has been continued again this year, aud a preliminary report can soon be made. The list of strains has been increased to nearly 200. Descriptions of the foliage, as well as the roots, are being made. In one instance, one strain appears as a different variety at least seven times, the seed being purchased from the same seed company in each case. The present year's work on the beet strains could not be completed in time for this report, since the roots are still in the ground.

BLOOMING DATES OF FRUIT TREES AND ORNAMENTALS

Continuing the practice of previous years, a record of the blooming dates of the varieties of fruits and ornamentals on the College Farm has been kept, and the dates for 1917 are presented herewith.

Table 7

Blooming Dates of Standard Apples at the College Farm, 1917

	First bloom	Full bloom		First bloom	Full bloom
Baldwin	5-14	5-23	Monmouth	5-18	5-24
Banana*	5-14	5-24	Montgomery **	5-17	5-24
Banks (Red Gravenstein)*	5-9	5-21	Oldenburg	5-7	5-21
Ben Davis	5-16	5-24	Otsego**	5-16	5-28
Clinton**	5-17	5-20	Rockland	5-17	5-24
Collins (Stark Champion)*	5-12	5-24	Rome*	5-17	6-1
Delicious*	5-15	5-21	Smith	5-14	5-26
Gilbert	5-17	5-24	Stayman*	5-12	5-24
Gravenstein	5-7	5-21	(Tompkins) King	5-12	5-21
Henry Clay*	5-12	5-17	Ulster*	5-19	5.21
Jonathan	5-14	5-23	Williams	5-14	5-26
Jane (Stark)*	5-19	5-21	Winterstein	5-19	5-24
King David*	5-14	5-24	Yellow Transparent	5-13	5-24

*Young trees.

**Young trees of varieties originated at the New York Agricultural Experiment Station, Geneva.

Table 8

Blooming Dates of Dwarf Apples at the College Farm, 1917

	First bloom	Full bloom		First bloom	Full bloom
Alexander	5-14	5-21	Livland	5-10	5-19
Baldwin	5-15	5-24	McIntosh	5-13	5-19
Banana	5-14	5-24	*Oldenburg (Duchess)*	5-14	5-21
Bietigheimer	5-14	5-19	Opalescent	5-17	5-24
Chenango	5-17	5-30	Red Astrachan	5-14	5-19
Delicious	5-15	5-21	Rhode Island Greening	5-14	5-30
Fall Pippin	5-15	5-31	Roxbury	5-14	5-30
Gravenstein	5-12	5-21	Sutton	5-19	5-21
Henry Clay	5-14	5-23	Twenty Ounce	5-14	5-21
Jonathan	5-14	5-28	Westfield	5-16	5-21
King David	5-13	5-24			

Table 9

Blooming Dates of Plums at the College Farm, 1917

Domestica

VARIETY	First bloom	Full bloom
Imperial Gage	4-28	5-7
Lombard	4-29	5-12

Japanese

	First bloom	Full bloom
Chabot	4-25	5-3
Shiro	....	5-10
Wickson	4-27	5-6

South Dakota Hybrids

VARIETY	First bloom	Full bloom		First bloom	Full bloom
Ezaptan	5-10	5-17	Opata	5-7	5-13
Hauska	4-29	5-11	Sapa	5-7	5-13
Iukpa	4-25	5-8	Toka	4-29	5-12
Kaga	4-28	5-2	Tokata	5-2	5-12

Table 10

Blooming Dates *of* Standard Pears at the College Farm, 1917

VARIETY	First bloom	Full bloom		First bloom	Full bloom
Anjou	5-7	5-14	Howell	5-10	5-14
Barsec	5-11	5-14	Kieffer	5-2	5-14
Bartlett*	5-7	5-17	Lady Clapp	5-10	5-14
Bosc	5-14	5-19	Lawrence*	5-2	5-12
Clairgeau	5-7	5-12	LeConte	5-2	5-14
Col. Wilder	5-11	5-19	Louise	5-12	5-15
Comice	5-14	5-19	Malines	5-11	5-17
Duchess	5-7	5-14	P. Barry	5-11	5-21
Early Wilder	5-10	5-24	Rutter	5-14	5-21
Elizabeth	5-10	5-14	Seckel*	5-10	5-17
Fred Clapp	5-11	5-17	*Sheldon**	5-2	5-12
Garber	5-7	5-12	Vermont	5-7	5-19
Golden Russett	5-12	5-15	Winter Nellis	5-13	5-17

*Old trees.

Table 11

Blooming Dates of Dwarf Pears at the College Farm, 1917

	First bloom	Full bloom		First bloom	Full bloom
Anjou	5-7	5-14	Hardy	5-2	5-13
Duchess	5-11	5-21	Lawrence	5-7	5-13
Easter	5-7	5-21	Louise	5-7	5-19

Table 12

Blooming Dates of Peaches and Nectarines at the College Farm, 1917

Peaches

VARIETY	First bloom	Full bloom		First bloom	Full bloom
Allbright October	4-25	5-10	Iron Mountain	4-28	5-10
Augbert	4-25	5-6	Japan Dream	4-25	4-29
Beers Smock	5-2	5-12	Lorenz	4-25	5-11
Bray's Rareripe	4-25	5-4	Mathews	4-25	5-4
Champion	4-25	5-6	Munson Free	4-25	5-6
Early Elberta	4-25	5-12	Pride of Franklin	4-25	5-10
Eaton	4-29	5-14	Rochester	4-28	5-10
Elberta (sport)	4-28	5-10	Salway	4-28	5-14
Frances	4-25	5-12	Slappey	4-29	5-14
Greensboro*	4-26	5-14	Susquehanna	4-25	5-10
Hottes Elberta	4-25	4-29			

*Dwarf.

Nectarines

	First bloom	Full bloom
Downtown	4-28	5-11
Elruge	4-28	5-14
Pitmaston Orange	4-28	5-17

Table 13

Blooming Dates of Small Fruits at the College Farm, 1917

Currants

VARIETY	First bloom	Full bloom		First bloom	Full bloom
Black Champion	4-28	5-21	Pomana	4-28	5-12
Cherry	4-28	5-12	Red Cross	4-28	5-12
Diploma	4-28	5-19	Wilder	4-28	5-12
Fay's Prolific	4-28	5-12	White Imperial	4-28	5-14
Perfection	4-28	5-18			

Gooseberry

Columbus	4-27	5-6	Industry	4-28	5-7
Crown Bob	4-28	5-14	Josselyn	4-28	5-7
Downing	4-27	5-6	Keepsake	4-27	5-17
Houghton	4-27	5-13			

Red Raspberry

Cuthbert	6-8	Marldon	6-4
Herbert	6-7	Ohta	6-4
June	6-4	*Perfection*	6-4
King	6-8	Ranere	6-4
Louden	6-10	Ruby	6-4
Marlboro	6-7		

Blackcap Raspberry

Black Diamond	6-1	Hunt	6-4
Black Pearl	6-3	Kansas	6-4
Cumberland	6-4	Plum Farmer	6-4
Gregg	6-6		

Purple Cane Raspberry

Cardinal	6-9
Columbian	6-8

Blackberry

Agawam	6-7	Nanticoke	6-17
Blowers	6-5	Ohio	6-3
Early Harvest	6-8	Rathburne	6-4
Eldorado	6-7	Robinson	6-12
Ewings	6-4	Snyder	6-4
Joy	6-7	Taylor	6-8
Kenoyer	6-4	Ward	6-4
Kittatinny	6-4	Watt	6-7
McDonald	6-3		
Mesereau	6-4	Logan Berry	6-7

Table 14

Blooming Dates of Strawberries at the College Farm, 1917

VARIETY	First bloom	Full bloom		First bloom	Full bloom
Advance	5-14	5-30	Kellogg's Premier	5-13	6-1[illegible]
Americus	5-13	5-30	Kellogg's Prize	5-16	6-[illegible]
Barrymore	5-19	6-4	Klondike	5-16	6-[illegible]
Big Joe	5-16	6-1	Lady Corneille	5-16	6-1[illegible]
Bucks	5-19	6-4	Late Jersey Giant	5-14	6-1[illegible]
Carolina	5-19	6-1	Marie	5-13	5-[illegible]
Chesapeake	5-21	6-4	Marshall	5-13	6-[illegible]
Collingwood	5-19	5-30	Mascot	5-21	6-[illegible]
Columbia	5-17	6-3	McAlpin	5-17	6-[illegible]
Doris	5-21	6-4	Missionary	5-13	6-[illegible]
Early Campbell	5-13	5-30	Monroe	5-14	5-[illegible]
Early Jersey Giant	5-16	6-4	Nellie Triumph	5-13	5-[illegible]
Early Ozark	5-13	5-30	Onward	5-17	6-[illegible]
Ed. Wilson	5-14	5-30	Productive	5-14	5-[illegible]
Emerson Joe	5-14	5-30	Progressive	5-14	5-[illegible]
Enormous	5-17	6-1	Prolific	5-16	6-[illegible]
Fairfield	5-18	5-30	Rewastico	5-19	6-[illegible]
First Quality	5-16	5-30	Sample	5-19	6-[illegible]
Forward	5-14	5-30	Shropshire	5-16	6-[illegible]
Gandy	5-20	6-4	Success	5-14	5-[illegible]
Helen Davis	5-19	6-1	Superb	5-14	6-[illegible]
Howard's 17	5-14	5-31	T. R. Hunt Seedling	5-17	6-[illegible]
Indiana	5-17	6-2	Twiley	5-17	6-[illegible]
Joe	5-16	5-30	Uncle Jim	5-10	5-[illegible]
Joe Johnson	5-14	5-30	Warren	5-17	6-[illegible]
John H. Cook	5-19	6-4	Wm. Belt	5-17	6-[illegible]

Table 15

Blooming Dates of Trees and Ornamentals at the College Farm and Its Environs, 1917

	First bloom	Full bloom
Acer platanoides	...	4-30
Acer pennsylvanicum	5-10	5-15
Acer pseudoplatanus	5-17	5-30
Acer saccharinum	3-23	3-26
Acer saccharinum wieri	....	4-30
Æsculus carnea	5-23	6-2
Berberis vulgaris	5-23	6-2
Betula alba, var. papyrifera	...	5-8
Buddleia spectabilis	6-24	...
Calycanthus florida	6-4	...
Cercis canadensis	5-23	6-1
Chionanthus virginica	...	6-15
Clethra alnifolia	....	7-15
Cornus florida	5-11	5-23
Cornus paniculata	...	6-19
Cydonia japonica	5-3	5-10
Deutzia crenata wateri	5-30	....
Deutzia gracilis	6-1	6-12
Deutzia scabra	6-19	....
Diervilla florida candida	5-31	6-8
Forsythia intermedia	....	5-18
Forsythia suspensa	4-28	5-7
Gaylussacia resinosa	5-14	5-26
Itea virginica	....	6-27
Juglans cinerea	6-1	....
Kalmia latifolia	....	6-19
Kerria japonica flore-pleno	5-21	5-26
Ligustrum ibota	....	6-21
Lindera benzoin	....	4-30
Lonicera tartarica	5-26	....
Magnolia glauca	6-4	....
Ostrya virginiana	5-3	5-11
Oxydendrum arboreum	....	7-24
Philadelphus coronarius gr. fl.	6-2	
Philadelphus lemoine candelabro	6-19	6-22
Platanus occidentalis	5-11	5-17
Populus balsamifera	....	5-14
Prunus avium	5-4	5-9
Prunus pissardi	5-4	5-7
Prunus pseudocerasus	5-4	5-11
Pyrus (Sorbus) aucuparia	5-23	6-1
Quercus bicolor	....	5-20
Quercus imbricaria	5-14	5-17
Rhododendron catawbiense	6-1	6-8
Rhododendron maximum	6-6	....
Rhus canadensis	5-22	5-28
Ribes aureum	5-7	5-23
Rosa multiflora	6-12	....
Rosa rugosa	5-30	6-8
Rubus odorata	6-16	....
Spiræa Anthony Waterer	6-24	6-28
Spiræa thunbergii	....	5-3
Spiræa VanHouttei	5-11	5-21
Stephanandra flexuosa	....	6-15
Symphoricarpos racemosus	6-19	....
Syringia vulgaris Marie LeGraye	5-25	5-30
Tamarix africana	6-10	6-16
Ulmus americana	3-26	....
Ulmus campestris	....	4-30
Vaccinum corymbosum	5-23	6-6
Viburnum acerifolium	....	6-16
Viburnum dentatum	....	6-17
Viburnum Opulus	6-1	....
Viburnum sterile	....	6-19
Wisteria chinensis	5-21	6-1
Yucca filamentosa	....	7-20

Table 16

Ripening Dates of Varieties of Blackberries at the College Farm, 1917

VARIETY	First	Heaviest	Last
Joy	8-2	8-13	8-27
Blowers	7-23	8-4	8-27
Eldorado	7-30	8-18	8-27
Early Harvest	7-13	8-2	8-13
Kenoyer	7-13	7-23	9-6
Kittatiny	7-28	8-6	8-25
Evergreen	7-23	....	8-20
Ewing's	8-15	8-20	9-18
Meserau	7-23	8-2	8-27
Nanticoke	8-17	8-27	9-14
Robinson	7-23	7-30	8-6
Snyder	7-26	8-2	8-25
Ward	7-23	8-6	8-27
Watt	7-23	8-4	8-27
Lucretia	7-18	7-31	8-15
Himalaya	8-2	8-13	8-27

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Table 17

Ripening Dates of Varieties of Raspberries at the College Farm, 1917

VARIETY	First	Heaviest	Last
Black Diamond	7-7	7-16	7-27
Cumberland	7-7	7-16	7-30
Kansas	7-7	7-12	7-27
Plum Farmer	7-7	7-13	7-27
T. R. Hunt Seedling	7-9	7-13	7-27
Black Pearl	7-13	7-16	7-23
Winfield	7-13	....	7-20
Cardinal	7-16	7-23	7-30
Columbian	7-13	7-23	8-2
Royal Purple	7-13	7-23	7-30
Gregg	7-13	7-16	7-25
Wineberry	7-25	8-6	8-13
Louboro	7-6	7-12	7-31
Columbian	7-9	7-18	7-31
Diamond	7-6	7-9	7-23
Cuthbert	7-13	7-20	8-2
June	7-13	7-20	7-27
Herbert	7-9	7-20	7-30
King	7-6	7-13	7-30
Marlboro	7-6	7-13	7-25
Otha	7-9	7-13	7-27
Ranere (St. Regis)	7-6	7-13	7-25
Ruby	7-6	7-13	7-23
Marldon	7-6	7-13	7-25
Marlative	7-9	7-16	7-27

WEATHER OBSERVATIONS

The spring of 1917 was exceptionally late because of the large percentage of cloudy or rainy days, combined with an average temperature somewhat below normal. These weather conditions greatly extended the blooming period of fruits, as may be noted in the tables, yet did not favor a heavy set of fruit in general. April 1 and 2 were exceptionally warm days, the maximum temperature being 83° and 76° F., respectively. This brought out blossoms on several trees of *Amygdalus davidiana* planted near the college nursery in 1915, although the standard varieties of peaches did not start to bloom at New Brunswick until April 25, 1917. Following this abnormally warm period, a snowfall of 7.25 inches occurred on the night of April 8.

Although the rainfall during April, May, June and July was not far from normal, the number of clear days was below the average. A severe drought occurred the latter part of July and during the entire month of August, accompanied by high temperatures. The total amount of rainfall from July 27 to September 1 was 0.87 inches. The precipitation during August was the lowest for any month at this Station in over fifty years, with the single exception of

July, 1910, when the total rainfall was only 0.28 inches. The warmest day of the year was July 31, with a maximum temperature of 98° F. This was the height of an exceptionally hot period during which the maximum temperatures were 95°, 98°, 97°, and 95° F., on four consecutive days beginning July 30 and ending August 2.

Table 18

Daily and Monthly Precipitation in Inches at the College Farm for the Year Ending October 31, 1917

	Nov. 1916	Dec. 1916	Jan. 1917	Feb. 1917	Mar. 1917	Apr. 1917	May 1917	June 1917	July 1917	Aug. 1917	Sept. 1917	Oct. 1917
1.	.11		T			T	.23	.10		T	1.78	
2.					.23		.03	.02			T	
3.			.21	T					1 86	.11		
4.					1.18		.07		.49			T
5.	.09	T	.43	.20	.09	.04	1.33					.05
6.	T		.01			.98	.09	.03			.06	.52
7.								.75			.01	
8.					.50			T			1.28	
9.	T	.52	.06	.27	T	.30	.02	T	.12	T		.30
10.			.02				.12	.05	.30			.06
11.		.20			.09			.14	1.45			T
12.		.67				T	.01	T	.03			.69
13.	.09		T			.01	.04		.07			.12
14.		.10	.63	T	.18			1.67	.05			
15.		.99	.22		.01			.02	1.22		.26	.01
16.	T	.20	T	.15			T	T		.12		
17.					.49		.20			.10		
18.		.05	T		T				.29			
19.						T			T			T
20.				.11		.04			T			.65
21.		.57	.18		.17	.08						2 40
22.		1.22		.29		.71	T			.04		
23.	.49			T		.08	.36			.03		
24.				.37	.42			.15		.18		
25.	.59		.06				T			.07		
26.						.23			.54			
27.		.31		.03	.37	.02	T	.35	.55			
28.		.30	.13	.35	.14						.21	.72
29.	T		.09		T		.89	.06		.04		
30.	.58		.17			T	.50	.28		.18	.03	1.82
31.			T		T							
Total	1.95	5.04	2.20	1.77	3.87	2.49	3.89	3.62	6.97	.87	3.63	7.34
Normal	3.30	3.74	3.28	3.61	4.08	3.45	3.72	3.33	6.42	5.75	3.93	4.11

The very small amount of rainfall during August severely checked the development of peaches ripening in that period. A heavy hail-storm of not over 10 minutes' duration caused serious damage to apples and other fruits at the College Farm on the afternoon of July 2. Other hail-storms occurred over limited areas of the state at various times during the summer, some of which caused considerable damage.

The total precipitation for the year was 43.82 inches, or 5.90 inches below normal. The heaviest rainfall in 24 hours was 2.40 inches on October 24. The heaviest snowfall was 9 inches on December 15. The last severe spring frost was on April 10, with a minimum temperature of 24° F., although a light frost occurred on May 4, with a minimum temperature of 32° F. The first killing frost in the fall occurred on October 13, with a minimum temperature of 32° F. Half-hardy plants, such as cannas and salvia, were not injured to any extent, however, until October 19 and 20.

The observations from November 1 to March 1 were made by Mr. R. M. Hubbard, and during the remainder of the year by Mr. William F. Schieferstein.

Table 19

Monthly Maximum and Minimum Means of Temperature (Degrees Fahrenheit) for the Year Ending October 31, 1917

Nov. 1916		Dec. 1916		Jan. 1917		Feb. 1917		March. 1917		April 1917	
Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	33.8	39.4	25.6	40.0	26.6	38.3	19.1	46.9	30.0	58.8	37.9
May 1917		**June 1917**		**July 1917**		**Aug. 1917**		**Sept. 1917**		**Oct. 1917**	
Max.	Min.	Max.	Min	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
66.8	44.5	79.5	58.7	82.5	65.4	84.3	63.5	71.6	51.1	63.5	39.9

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY

Department of Animal Husbandry

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Report of the Department of Animal Husbandry

J. M. HUNTER.

INTRODUCTION

The department of animal husbandry has endeavored to continue the experiments outlined in the report of last year. A few minor changes were necessary, owing to the extremely high cost of feed necessary in conducting feeding experiments. The following experiments were again taken up during the past year:

A. The free-choice self-feeding system vs. hand-feeding of market pigs on forage crops.

B. The value and economy of black strap molasses or low-grade molasses in the brood sow ration.

C. Feed requirements of fall pigs on the self-fed free-choice system when colony houses were used as winter quarters.

D. The free-choice self-feeding of different grain rations to fall pigs intended for market.

A.—THE FREE-CHOICE SELF-FEEDING SYSTEM VS. HAND-FEEDING OF MARKET PIGS ON FORAGE CROPS

This experiment was outlined and started June 14, 1916. A preliminary report of the experiment appeared in the report of the department for the previous year.

Object of the Experiment

The object of this experiment was to determine whether the free-choice self-feeding of concentrates would produce a cheaper 200-pound market pig than where the grain ration was limited until the forage crop season was over. After the forage season all lots were to be allowed access to self-feeders. Forage crops were used in both the self-fed and hand-fed lots.

Summary of Trial

Forty-eight head of weanling pigs averaging 49 pounds were divided into 8 lots of 6 pigs each. Lots 1 to 4 inclusive were allowed free choice of shelled corn, wheat middlings and 60 per cent digester tankage in separate compartments of the self-feeder. Lots 5 to 8 inclusive were given a 2 per cent ration made up of the same feeds during the forage-crop season, after which they were allowed access to the self-feeder in the same manner as the first four lots. Thus 4 lots were on a limited grain ration while on forage and the others were self-fed or full-fed by the free-choice system, and all lots were self-fed after the forage season. All lots were allowed free access to fresh water and salt at all times. Table 1 shows the results of the first period from June 14 to October 2. It will be noted that the self-fed lots in every case require more total pounds of feed to produce 100 pounds than did the hand-fed lots. It will also be noted that the self-fed pigs gained at a considerably greater rate than those limited in the grain allowance. Table 2 shows the results of the second period from October 2 to December 12. (Because of some difference in the size and age of the pigs within each lot it was decided to remove the pigs from each lot as soon as they attained a weight of 200 pounds. Thus the weights of the pigs in lot 1 at the beginning of the second period were somewhat reduced after the individuals weighing 200 pounds had been removed. It was also necessary to dispose of a number of the pigs in this experiment before the finishing period was completed, thus lots 5 and 6 of the first period were used for lot 2 in the finishing period, while 17 animals from lots 1, 2, 3 and 4 of the first period make up lot 1 of the finishing period.)

From these figures it will be noted that considerable change has come about in the amount of feed necessary to produce 100 pounds of gain as the various lots approach the 200-pound weight.

Lot 1, which continued to receive a free choice of corn and tankage from the self-feeder (the feeding of wheat middlings was discontinued in all lots at the beginning of the finishing period) required only slightly over 500 pounds of concentrates to produce 100 pounds of gain, while lot 2 required considerably over 700 pounds of concentrates to produce 100 pounds of gain.

Table 1

Results of Experiment on the Use of the Self-Feeder for Hogs
First Period—June 14 to October 2

	* 1	2	3	4	5	6	7	8
NUMBER OF PIGS	6	6	6	6	6	6	6	6
Average Initial weight (lbs.)	46.00	45.80	47.00	52.16	45.16	44.6	48.6	51.16
Average final weight (lbs.)	155.50	148.33	161.60	125.50	117.58	113.00	84.33	82.00
Average total gain per pig (lbs.)	109.50	102.53	114.60	73.34	72.42	68.10	35.73	30.84
*Average daily gain per pig (lbs.)	1.03	0.96	1.09	0.916	0.657	0.622	0.445	0.44
Grain eaten (lbs.)								
Corn	1854.00	1800.00	2044.00	1430.70	601.15	601.15	450.75	401.25
Middlings	140.00	121.90	145.00	120.00	115.95	115.95	87.75	77.85
Tankage	83.00	86.65	89.00	97.90	55 90	55.90	46.50	39.90
Feed for 100 pounds of gain (lbs.)								
Corn	282.10	292.59	297.26	325.10	138.34	146.47	210.25	216.79
Middlings	21.30	19.60	21.08	27.27	26.68	28.25	40.93	42.07
Tankage	12.63	14.08	12.94	22.34	12.86	13.62	21.69	21.56
Total feed per 100 pounds of gain (lbs.)	316.03	326.97	331.28	374.61	177.88	188.34	272.87	280.42

*Figures on average daily gain per pig take into account the animals removed prior to October 2.

By comparing the amounts of total feed eaten by all lots durin the first and second periods it will be seen that considerably mor feed was consumed in the final period, or after the forage cro

Table 2

Results of Experiment on the Use of the Self-Feeder for Hog Second Period—October 2 to December 12

	LOT I	LOT II
Number of pigs	17.0	12.0
Average initial weight (lbs.)	130.8	115.25
Average final weight (lbs.)	187.4	156.5
Total gain (lbs.)	962.2	495.0
Average gain per pig (lbs.)	56.6	41.25
*Average daily gain per pig (lbs.)	1.029	0.802
Total grain eaten		
Corn	4722.0	3525.0
Tankage	295.	198.
Grain eaten per 100 pounds of gain (lbs.)		
Corn	492.52	712.12
Tankage	30.65	40.00
Total grain eaten per 100 pounds of gain (lbs.)	521.40	752.12

*Figures on average daily gain per pig take into account animals removed befor December 12.

Table 3

Summary of Experiments with Self-Feeder for Hogs First Period—June 14 to October 2

	Self-fed	Hand-fed
First Period: June 14 to October 2.		
Total gain per pig (lbs.)	106.010	70.410
Feed eaten per pig (lbs.):		
Corn	304.500	100.191
Middlings	21.817	19.325
Tankage	14.137	9.316
Total feed eaten (lbs.)	340.454	128.832
Feed for 100 pounds of gain (lbs.)	321.150	182.970
Total feed cost per pig	$5.809	$2.234
	Self-fed	Self-fed
Second Period: October 2 to December 12.		
Total gain per pig (lbs.)	56.600	41.250
Feed eaten per pig (lbs.):		
Corn	277.764	293.750
Tankage	17.353	16.500
Total feed eaten (lbs.)	295.117	310.250
Feed for 100 pounds of gain (lbs.)	521.408	752.121
Total feed cost per pig	$5.082	$5.318

season was over. Table 3 shows the total feed costs for lots 1 and 2, also of lots 5 and 6 for the first period and lot 1 and 2 for th second period.

The sum of the feed costs for the self-fed pigs for both periods as compared with the total cost for the two periods of the hand-fed (and later self-fed lot) shows a fair margin in favor of the self-fed pigs according to the figures in table 4. (These figures are based on the assumption that both lots would continue at their same rate of gain until a 200-pound weight was made.)

Table 4

Feed Cost and Profit on Self-Fed and Hand-Fed Pigs (45 to 200 Pounds)

	Self-fed	Hand-fed (finished on self-feeder)
Cost per pig, first period, June 14 to October 2	$5.809	$2.234
Cost per pig, final period, October 2 to December 12	6.213	10.934
Total feed cost per pig, 45 to 200 pounds	12.022	13.168
Selling price of 200-pound pig	24.00	24.00
*Profit per pig above feed cost	11.978	10.842
Additional days required by hand-fed lot (finishing on self-feeder) to make 200-pound weight		38.5

*Corn—$0.94 per bu.
Middlings—$1.70 per cwt.
Tankage—$2.50 per cwt.
Hogs—$12.00 per cwt.

These figures are based on the assumption that both lots would continue at their respective rates of gain until all animals averaged 200 pounds.

Figuring the price of hogs at $12.00 per cwt., each 200-pound hog would be worth $24.00. The profit above feed cost for the self-fed pig would be $11.97 as compared with $10.84 for the hand-fed pig. In estimating the feed requirements and time necessary for all lots to make an average of 200 pounds per pig, we find that the straight self-fed pig not only requires less feed to make his required weight, but reaches an average of 200 pounds in 38 days less time than the lots fed a 2 per cent ration and finished on the self-feeder.

B.—VALUE AND ECONOMY OF MOLASSES IN THE BROOD SOW RATION

Under ordinary conditions of feed prices, black-strap or low-grade molasses can be purchased at from 9 to 10 cents a gallon. At this price molasses often supplies the digestible food nutrients at a lower cost per pound than some of our common grain feeds, such as

corn, rye, etc. Experiments have been outlined in an attempt to determine whether or not molasses at a slightly lower cost per unit of feeding value would be a practical and economical substitute for corn and other grains.

A trial in 1916 substituting molasses for corn in a ration for growing gilts on forage crops brought out the fact that molasses and a very little digester tankage in addition to the forage crops was fairly satisfactory as a growing ration. It was found that out of a lot of five gilts receiving this ration, three farrowed successfully while the other two would class as failures.

Summary of Second Trial

A second trial was conducted during the winter of 1916-17, with 24 head of brood sows ranging in age from 2 to 4½ years. The 24 head were divided into four lots of 6 sows each. In making up the lots, effort was made to equalize the groups on the basis of their ages, past performance and condition rather than to secure an equal weight in all lots. The four lots were fed as follows:

Lot 1. Limited amounts of
- Ear corn
- Digester tankage
- Mangels
- Alfalfa hay self-fed in racks.

Lot 2. Limited amounts of
- Corn meal, Alfalfa meal, Black strap molasses — Equal parts by weight.
- Mangels

Lot 3. Limited amounts of
- Hominy meal, Alfalfa meal, Black strap molasses — Equal parts by weight.
- Mangels
- Alfalfa hay self-fed in racks.

Lot 4. Limited amounts of
- Alfalfa meal, Black strap molasses — Equal parts by weight.
- Mangels
- Digester tankage
- Alfalfa hay self-fed in racks.

The sows were placed on the various rations for a 10-day preliminary trial, after which the experiment was continued for 120 days. The sows were bred immediately before the experiment began or very soon after. During the 120-day period, the following conditions were noted. Lot 4, receiving straight molasses and alfalfa meal with a very small percentage of tankage, had a tendency to scour throughout the period. Three of the sows on the molasses and alfalfa ration, after three periods of heat and being mated to the boar each time, failed to settle in pig. Upon being removed from the experiment and allowed a ration of ear corn, alfalfa hay and digester tankage, the three sows each returned in heat for the fourth time and were bred and safely settled in pig.

Table 5

Results of Feeding Experiment with Brood Sows

Lot Number	1	2	3	4
Number of sows	6.	6.	6.	6.
Initial weight, (lbs.) November 21	2130.	1957.	1887.	2108.
Final weight, (lbs.) March 21	2620.	2670.	2670.	2399.
Total gain (lbs.)	490.	713.	483.	291.
Average daily gain per sow (lbs.)	0.686	1.04	0 67	0.49
Average daily ration (lbs.)	9.949	12.728	12.64	12.887
Ear corn (shelled corn basis)	3.938			
Corn meal		2.30		
Hominy			2.30	
Molasses		2.30	2.30	3.538
Tankage	0.191	0.238	0.229	0.311
Alfalfa hay	0.577	0.390	0.361	
Alfalfa (ground)		2.30	2.30	3.538
Mangels	5.193	5.21	5.15	5.50
Cost of feed per sow for 120 days	$11.48	$13.88	$12.96	$11.34
Cost of daily ration per sow	$0.095	$0.115	$0.108	$0.094

Corn ... $1.00 per bu.	Tankage ... $50.00 per ton
Corn meal ... $1.10 per bu.	Alfalfa hay ... $20.00 per ton
Hominy ... $33.00 per ton	Alfalfa (ground) ... $24.00 per ton
Molasses ... $0.10 per gal.	Mangels ... $5.50 per ton

Animals removed from the experiment.
Lot 4, February 8, 1 sow, weight 505 pounds (soon due to farrow).
Lot 2, February 12, 1 sow, weight 402 pounds (soon due to farrow).
Lot 4, February 19, 3 sows, weight 1170 pounds (did not settle in pig).
Lot 1, March 15, 1 sow, weight 390 pounds (soon due to farrow).

One sow in lot 1 and one in lot 3 failed to settle in pig, and upon being removed from the experiment and placed on a ration similar to that of the other three sows from lot 4, did not breed. Upon final examination they were found to be sterile. Table 5 presents some interesting facts concerning the cost of the rations fed to the

different lots. In so far as possible, it was planned to allow the same percentage of digestible nutrients and the same amount of total digestible nutrients to all lots, therefore the gains made by the different lots may be considered a fair indication as to which rations are best adapted to the production of gains in pregnant brood sows. The greater gain made by lot 2 is somewhat offset by the fact that three of the animals in this lot were somewhat thinner in condition than the average of the 24 head at the beginning of the experiment.

Conclusions

1. No animals refused their rations or went off feed during the 120-day period of the experiment.

2. All lots appeared to relish their respective rations with the exception of 2 sows in lot 4, which did not take to the mixture of molasses and alfalfa hay very well during the 10-day preliminary period and first few days of the experiment.

3. All lots continued to gain in weight when receiving the same amounts of protein, energy value and the same total amount of digestible nutrients from the different feed sources.

4. The same proportion of protein to carbohydrates and fat and also the same total of digestible nutrients in the molasses and ground alfalfa ration, produced less gain in weight than in any of the other rations.

5. The sows receiving a ration of molasses and alfalfa hay appeared to scour slightly throughout the period of the experiment. The sows in this lot required more water and showed an abnormal secretion of urine as compared with the animals receiving equal parts of corn meal, molasses, alfalfa hay, or those receiving hominy, molasses and alfalfa hay.

6. Low-grade molasses is not a satisfactory sole substitute for corn in the brood sow ration even at a lower cost.

7. Grain rations supplemented with molasses produced greater gains than where no molasses was used or where molasses was substituted entirely for grain.

C.—FEED REQUIREMENTS OF FALL PIGS ON THE SELF-FED FREE-CHOICE SYSTEM WHEN COLONY HOUSES WERE USED AS WINTER QUARTERS

The colony house system has proven satisfactory at this Station as winter quarters for mature animals. Brood sows housed in the colony house and fed out-of-doors during the winter months gain in weight on a fair amount of feed and farrow successfully during the early spring months. For housing fall pigs during the winter months the question of how successfully the colony house answers the condition is not definitely known.

Table 6

Results of Feeding Experiment with Fall Pigs in Colony Houses as Winter Quarters

(First Period)

Number of days on experiment	45
Number of sows	7
Number of pigs	*38
Initial weight of sows (lbs.)	1615
Final weight of sows (lbs.)	1670
Total gain of sows (lbs.)	55
Initial weight of pigs (lbs.)	289.70
Final weight of pigs (lbs.)	802.50
Total gain of pigs (lbs.)	512.80
Total gain sows and pigs (lbs.)	**567.80
Feed eaten (lbs.)	
Corn	2297.00
Middlings	1122.00
Tankage	182.00
Total feed eaten	3601.00
Feed for 100 pounds of gain	634.20
Corn	404.54
Middlings	197.60
Tankage	32.05

*Two pigs died.
**Including 55 pounds of gain on sows.

The object of this experiment was to secure some data on the cost and rate of gains made by fall pigs when housed under the colony-house system and fed liberally throughout the winter months. A preliminary trial with 7 brood sows and 38 suckling pigs was started on November 4, 1916, and continued until May 31, 1917. The sows were pure-bred Duroc-Jerseys with their first litter of pigs. Five of the litters were cross-breds, being sired by a pure-

bred Poland China Boar, while the other two litters were purebred Duroc-Jerseys. The sows and their litters were placed in two lots of one-quarter acre each. The colony houses were placed in each lot, one having a board floor and the other a ground floor. The sows and their litters were given free access to self-feeders containing shelled corn, wheat, middlings and digester tankage. Salt was allowed at all times, in the form of rock salt; water was also supplied in troughs at all times except in freezing weather when it was thawed out three times daily, allowing the animals access for one or two hours each morning, noon and night.

Table 7

Results of Feeding Experiment with Fall Pigs in Colony Houses as Winter Quarters

(Entire Period)

Number of pigs	*38
**Initial weight (lbs.), November 4, 1916	289.70
**Final weight (lbs.), May 31, 1917	4445.00
Total gain (lbs.)	4155.30
***Total days	201.33
Average daily gain per pig (lbs.)	0.543
Total feed eaten (lbs.)	20469.27
Feed eaten (lbs.)	
Corn	16124.48
Middlings	2939.45
Tankage	1123.84
Skim Milk	281.50
Total feed for 100 pounds of gain (lbs.)	492.60
Feed for 100 pounds of gain (lbs.)	
Corn	388.046
Middlings	70.739
Tankage	27.045
Skim Milk	6.774
Cost of 100 pounds of gain	$11.84

Hogs—$14.50 per cwt.
Corn—$1.35 per bu.
Middlings—$2.35 cwt.
Tankage—$3.00 cwt.
Skim milk—$0.25 cwt.

*Two pigs died during the first two weeks of the experiment, also 6 head were removed on April 21. However, the figures do not take into account the difference in numbers from deaths.

**Includes 55 pounds of weight of sows.

***201.33 represents average length of time in days per pig.

Table 6 shows the results of the first period of the experiment, or the period before the pigs were weaned. All sows were removed on December 21 and the 36 head were equally divided between the two lots.

Table 7 shows the results of the entire period from November 4 to May 31. During the first period, while some of the sows with the largest litters lost slightly in weight, there was a total of 55 pounds of gain in the brood sows which was accredited to the gains in the pigs. Figures from tables not here given show that during the mid-winter periods the pigs required considerably more feed for 100 pounds of gain, even during the suckling period, than during the latter part of the experiment. It was also noted that while the pigs were in high condition, yet they showed very little growth during the severe winter weather. During the period, 4 head of pigs developed a runty appearance and were removed to pens in the central house for a period of 75 days. During this time they improved so that they were put back with the other animals on March 27. Their feed was included in the figures given in table 8.

On April 21, six head were removed and the remaining 30 head were given access to a 2½ acre plot of rye in addition to the self-feeders containing corn, middlings and tankage. While comparative figures are not here given, it was found that upon the addition of green pasture in connection with the grain ration, the rate of growth increased rapidly and the total amount of feed for the production of 100 pounds of gain was lower.

Conclusions

From this preliminary trial, while it was not possible to carry on a check lot during the first season, it is evident that 486 pounds of concentrates for 100 pounds of gain is rather high—in view of the fact that the experiment covers the period of greatest growth in the animals. From observations throughout the winter it seemed evident that these pigs would have made a much better showing had they been given access to warmer and drier sleeping pens.

During the winter, and particularly in severe weather, the pigs would huddle together in the colony houses to keep warm, and in this way the small pigs were crowded out to the edge and not given an equal chance with the other pigs.

As the self-feeders were out-of-doors, it was necessary for the pigs to stand at the self-feeder during a greater part of the day in order to satisfy their appetites. On several occasions during severe storms the animals would remain in the house for 8 or 10 hours at a time without operating the self-feeder.

It would seem that where conditions permitted young pigs to go to and from the self-feeder at will regardless of weather conditions, and where they might remain in dry, well-ventilated quarters, the conditions for economical gains and greater growth would be greatly improved over the colony-house system where pigs are fed out-of-doors in all kinds of weather. It is hoped that the check lots will bring out more complete results than were possible in this preliminary trial.

The results of this trial seem to indicate that young growing pigs cannot make satisfactory gains when fed out-of-doors and housed in the A-shape colony house. It is hoped that subsequent trials with check lots will show more clearly the advantage of providing more comfortable quarters for fall pigs.

D.—THE FREE-CHOICE SELF-FEEDING OF DIFFERENT GRAIN RATIONS TO GROWING AND FATTENING FALL PIGS

The experiment was outlined and a 10-day preliminary trial was started on December 27, 1916, for the purpose of determining the most economical combination of feeds for growing and fattening *pigs on the free-choice self-fed method.*

Summary of Experiment

Forty head of 42-pound pigs were divided into 4 lots of 10 pigs each. The pigs were allowed free choice of feeds from separate compartments of the self-feeder. The different lots received their rations as follows:

Lot 1	Lot 2	Lot 3	Lot 4
Shelled corn Tankage Salt	Shelled corn Wheat middlings Tankage Salt	Shelled corn Wheat middlings Tankage Skim milk Salt	Shelled corn Wheat middlings Tankage Ground alfalfa Salt

All feeds were self-fed with free choice with the exception of skim milk to lot 3, which was limited to 50 pounds per day or 5 pounds per animal. Ground alfalfa was fed on the cement floor and

in such amounts as the animals would clean up during the day. The lots were given access to a central hog house having a cement floor and sleeping pens with wood "over-lays."

Table 8

Results of Experiment on Self-Feeder for Growing and Fattening Fall Pigs

RATIONS	Lot 1 Corn Tankage Salt	Lot 2 Corn Middlings Tankage Salt	Lot 3 Corn Middlings Tankage Skim Milk Salt	Lot 4 Corn Middlings Tankage Ground Alfalfa Salt
Number of pigs	10.	10.	10.	10.
Average initial weight (lbs.)	45.1	42.0	40.4	43.3
Average final weight (lbs.)	188.1	195.8	204.1	183.2
Total gain (lbs.)	143.1	153.8	163.7	139.9
Average daily gain per pig (lbs.)	0.9868	1.086	1.256	0.959
Feed eaten (lbs.)—				
Corn	5121.00	4761.00	4947.00	4633.00
Middlings		696.00	482.00	641.00
Tankage	442.00	273.00	238.00	275.00
Skim milk			4800.00	
Alfalfa hay				228.00
Total feed eaten (lbs.)	5563.00	5730.00	6147.00	5777.00
Average daily ration per pig (lbs.)	3.843	4.046	4.717	3.956
Feed for 100 pounds of gain (lbs.)—				
Corn	357.86	309.55	302.19	331.16
Middlings		45.25	29.44	46.81
Tankage	30.88	17.75	14.53	19.65
Skim milk			293.21	
Alfalfa hay				16.29
Total feed per 100 pounds of gain (lbs.)	388.74	372.55	639.37	412.91
Cost of 100 pounds of gain	$9.65	$9.05	$9.14	$9.80
Profit per pig above feed cost	7.08	8.38	8.77	8.57
Additional days necessary to make same gain as lot 3	20.8	9.1	0.0	24.8

Note: Hogs—$14.50 per cwt.
Corn—$1.35 per bu.
Middlings—$2.35 per cwt.
Tankage—$3.00 per cwt.
Alfalfa hay—$20.00 per ton.
Skim milk—$0.25 per cwt.
Skim milk may be reckoned on the dry-matter basis as 10 per cent. total liquid milk.

Skim milk was fed to lot 3 for 96 days, after which it was discontinued. The skim milk used was machine-separated milk, pasteurized and fed sweet. The alfalfa hay used in lot 4 was ground in a combination cutter and grinder. This was fed for the first 114 days of the experiment, after which it was discontinued.

One pig in lot 4 did not make normal gains, but showed a rather stunted condition throughout the experiment. This fact perhaps partially accounts for the lower gains made by this lot.

Table 8 gives a summary of the results from the 4 lots receiving the different rations.

Conclusions

Lot 3, receiving shelled corn, wheat middlings, tankage and skim milk, produced the greatest gains, ate the most feed and returned the greatest profit. The feed for 100 pounds of gain was only slightly more than that required by lot 2, while the rate of gain was more rapid.

The estimated time necessary for lot 2 to reach the same total weight as lot 3 would be 9.1 days of additional feeding. Lot 1 on corn and tankage did quite well, considering that they were limited to two feeds for the entire 190-day period. Comparing lots 1 and 2, it will be noticed that the middlings offset the amount of tankage required by a considerable margin. The middlings replaced considerable corn, but the total feed for 100 pounds of gain approached more nearly the same level. On the other hand, when feeds are at the prices quoted, wheat middlings effected a saving of 50 cents on each 100 pounds of pork, or approximately 80 cents on each pig from weaning time to market. Lot 4 on corn, middlings, tankage and alfalfa meal made the least gain at the greatest feed cost. While this is perhaps partially due to the fact that one of the pigs did not develop to the same degree as the other animals in the same lot, yet the fact remains that ground alfalfa is not relished by young fattening pigs having access to the self-feeder containing the above-mentioned feeds. When 2 pounds of ground alfalfa is all that pigs of 100 to 150 pounds will consume per day it is not likely that such a small amount would effect any considerable saving or tend to cheapen the ration. It may be possible that ground alfalfa lessens the appetites of pigs on the self-feeders.

Comparing lot 4 with lot 2, receiving the same feeds with the exception of ground alfalfa, we find that the requirements for 100 pounds of gain were greater in lot 4 for each feed except tankage.

In conclusion, it may be stated that where fall pigs are fed on the self-feeder in dry lot, corn and tankage may profitably be supple-

mented with wheat middlings during the early part of the growing and fattening period at least, provided the price is within reason.

Skim milk is a valuable supplement to corn, wheat middlings and tankage if it can be purchased at a reasonable price (the value of skim milk will depend upon the price of other feeds). Skim milk has a greater economical value for young growing and fattening pigs than for pigs nearing market weight.

OTHER DEPARTMENT ACTIVITIES

The following changes have come about in the organization of the animal husbandry department during the past year:

Harry J. Rockafeller, acting as field assistant in the control and eradication of hog cholera, resigned April 1, 1917, and enlisted in the United States Army.

On September 1 the hog cholera control work which had been under the direction of the animal husbandman was transferred to the Bureau of Animal Industry of the State Department of Agriculture at Trenton, N. J.

In addition to the experimental work which was carried on in connection with the swine herd of this department, 249 head of stock have been sold during the past year. Ninety-four head were pure-bred breeding stock placed on farms over the State at reasonable prices.

Four head of pure-bred milking Shorthorn females (1 cow and 3 heifers) were purchased during the past fall as a foundation herd. The total cost was $1,725. These animals will be kept at the Experiment Station dairy barns where records of their production will be made. They will also be used for student judging work in both the long and short courses.

A flock of 15 head of pure-bred Horned Dorset sheep (14 ewes and 1 ram) were purchased by the department in October, 1917. They will be used experimentally as well as for judging specimens for agricultural students.

REPORT OF THE DEPARTMENT OF POULTRY HUSBANDRY

Department of Poultry Husbandry

HARRY R. LEWIS, M. AGR., *Poultry Husbandman.*

WILLARD C. THOMPSON, B. SC., *Assistant in Poultry Research.*

*ROY F. IRVIN, B. SC., *Specialist in Incubation Studies.*

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MORRIS SIEGEL, *Poultry Foreman.*

ELMER H. WENE, *Supt. Vineland Contest.*

*Resigned September 30, 1917.
†Appointed November 15, 1916.

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Report of the Department of Poultry Husbandry

HARRY R. LEWIS

I

INTRODUCTION

The poultry husbandman is pleased to report a very progressive and successful year's work in the many activities of the department. The great and increasing interest among poultrymen of all classes throughout the State in the work of the poultry department, both at New Brunswick and at Vineland, is extremely gratifying. The completion of the new poultry farm on the College Farm at New Brunswick has been accomplished, making possible more complete and valuable experimental work. The performance of the birds at the Vineland International Egg Laying and Breeding Contest has been exceptional and has created nation-wide interest. The research data secured from this plant will afford excellent material for study. With the completion of the new poultry farm many new projects have been started and old projects strengthened, as will later be described. The demand for extension work throughout the state has exceeded that of all previous years. The correspondence of the department has been exceptionally heavy, especially in relation to and as a result of the work at Vineland. The success of the year's work is due in large part to the hard work and cooperation of the members of the department staff.

The report of the poultry husbandman is herein presented under four distinct headings, viz., Administration, Experimental Work, the Vineland Contest, and Educational Activities.

II

ADMINISTRATION

Staff Changes

During the year numerous changes and additions have been made in the department staff. Mr. Roy F. Irvin, who was pursuing special incubation studies, has resigned to follow larger opportunities in Michigan. The resignation of Mr. William Pape was accepted and his position filled by Mr. William B. J. Reitze, a graduate of the Short Courses in Poultry Husbandry. The resignation of Miss Kathryn L. Reed was accepted and her position filled by Miss Louise Treffinger. Additional clerical help has been secured for extension services in the person of Miss Dorothy M. Crouch. Numerous changes in the assistants at the Vineland Contest staff have been made, due to requirements for military service, and because the salaries paid were insufficient to retain their services. Mr. Irving Troll and Mr. William Whynman, senior students in poultry husbandry, have co-operated with the poultry staff in compiling data pertaining to poultry farm management and poultry farm survey problems, and the individuality factor as affecting experimental analysis of the productivity of laying hens. Numerous temporary assistants and helpers have been secured during the year as the work required. At the present time the staff is made up as follows:

Harry R. Lewis, B. Sc., M. Agr., Poultry Husbandman.
Willard C. Thompson, B. Sc., Assistant Poultry Husbandman.
Victor G. Aubry, B. Sc., Extension Specialist.
Ralston R. Hannas, B. Sc., Assistant in Research.
William Whynman, B. Sc., Special Nutrition Studies.
Morris Siegel, Foreman.
Edward H. Stokes, Assistant.
William B. J. Reitze, Assistant.
Antal Kiss, Assistant.
Mary B. Reed, Stenographer.
Dorothy M. Crouch, Stenographer.
Louise Treffinger, Stenographer.

The Vineland International Egg Laying and Breeding Contest staff is made up as follows:

Harry R. Lewis, Supervisor.
Elmer H. Wene, Superintendent.
James G. Rugh, Foreman.
George W. Woods, Assistant.
Eugene W. Bates, Assistant.
Faith R. Lewis, Clerk.

Regular monthly staff meetings have been held, as in the past, and an innovation introduced in the form of regular weekly council meetings, at which the head of each division of the poultry work is present, bringing about a more complete organization of the work, and a greater interest and cooperation in all branches. The following of a regular program in both staff and council meetings has resulted in very definite benefit in the short time spent in such consultation.

Future Plans

The work for next year will be conducted along the same general lines as during the past year, greater effort and more time being spent in completing and promoting experimental activities. Much time will be spent in working over the first year's data of the Vineland Contest and in publishing the findings, in both technical journals and publications of the Station. Much effort must be spent in carrying on the second year's work at Vineland, which includes the pedigree breeding of the one thousand yearling hens which are now at the Contest. Every effort will be made to make the contest work successful in every way, as it is the first time that such a project has been attempted.

Correspondence

The time and attention which must be given to correspondence is becoming more burdensome each year. The range of inquiries are becoming wider and more varied, and with the growth in popularity of New Jersey's poultry work many more requests for information and help are coming from distant states. During the past year 16,054 letters have been written by the department staff, classified as follows:

Administrative	4,000
Extension letters other than by extension specialist	2,600
Extension letters by extension specialist	4,179
Vineland Egg Laying Contest and allied work	5,275
Total	16,054

A carefully planned system of form letters and a simplified method of dictation have resulted in the saving of much time in answering correspondence and greater satisfaction to the correspondent.

Miscellaneous Duties

During the past year the poultry husbandman has had the opportunity to attend three extremely important conventions. The first of these was the Eastern Sectional Meeting of the American Association of Instructors and Investigators in Poultry Husbandry, held during the last week of July at the Massachusetts Agricultural College at Amherst, Mass. This meeting was very widely attended and much valuable material was secured to aid in creating confidence among producers and to aid in conducting campaigns to increase the amount and efficiency of poultry production. The assistant in poultry research also was present at the Amherst meeting.

The following resolution unanimously adopted at the above convention typifies the attitude of those present, and is given here as it has a very important bearing upon the future of the poultry business.

RESOLUTION

Whereas, The situation confronting the poultry producers and consumers of the nation, demands wise, patriotic, immediate and aggressive action, and

Whereas, The abnormally high price of feed has caused and is causing extensive and unwise sacrifice of valuable poultry which, if continued, is certain to result in seriously reducing the supply of breeding stock and poultry products, thus resulting in loss to both producer and consumer; and

Whereas, The economic life sustaining values of poultry and eggs in the feeding of the nation requires that the normal supply be maintained; therefore

Be It Resolved, That we, the members of the American Association of Instructors and Investigators, in conference assembled, do hereby appeal to all who keep poultry to meet the situation by greater efficiency which should result in producing more eggs and poultry meat from the present amount of stock, or the present amount of eggs and poultry meat from less stock, in the belief that the poultry producers who practice the most approved methods—better stock and management—will be able to meet their national obligation without seriously sacrificing their financial interest until the close of the war, when it is confidently believed that there will be an unprecedented demand for breeding stock and poultry products from this and foreign countries, and at which time the cost of production, on account of cheaper feed, labor and equipment,

will be such that poultrymen will meet a just reward for their faith, courage and loyalty in meeting the present critical situation.

Resolved, That these resolutions be given wide publicity through the Food Supply Commission or similar agencies in the various states, and the press.

(Signed) PROF. H. R. LEWIS, *Secretary*.

The second convention attended was that of the Connecticut Poultry Association at Storrs, Conn., held during the second week of August. At this conference the writer had the greatly appreciated opportunity to visit with Mr. Edward Brown, of England, and to confer with him relative to the effect of the war upon poultry production in England and what we may expect to be the results upon the American poultry industry.

The third convention attended was that of the American Poultry Association, held at Milwaukee during the last week of September. The assistant in research also attended this meeting. The writer attended as the representative of Rutgers College and the New Jersey Agricultural Experiment Station, and is gratified to have had the opportunity to help shape much of the constructive and emergency legislation which was enacted at this, one of the greatest conventions the association has ever held. The following resolutions, framed by the New Jersey delegates, were unanimously passed by the convention and all possible steps taken to put them into action immediately.

Resolution Presented at the Forty-Second Annual Convention of the American Poultry Association in Conference Assembled at Milwaukee, September 25 to 28, 1917

PURPOSE

To picture with broad conception the conditions now affecting the poultry industry and the probable reactions resulting upon the conclusion of peace, in order to thereby insure confidence among the great mass of poultry producers.

RESOLUTION

Whereas, The economic life of our nation, due to the exigencies of war, requires that the production of all highly nutritious food products, especially poultry meat and eggs, must be materially increased in amount and in efficiency of production;

Whereas, Under the constantly growing pressure of increased cost of feed and scarcity of labor the tendency to reduce poultry flocks in size and number is very apparent; which practice, if continued, will result in permanent loss to both producer and consumer, as well as a very serious loss to the industry, because of the reduction in the supply of suitable standard-bred breeding stock; and

Whereas, This national situation, confronting poultry producers and consumers alike, demands for the best interest of ourselves and nation, which in a whole-hearted and cooperative spirit is the patriotic duty of all; therefore

Be It Resolved, That we, the members of the American Poultry Association assembled in annual convention, do herewith earnestly appeal to all poultry keepers to study the situation from its local as well as its national aspect, and to avoid hysterical action through the killing of productive birds, with its accompanying personal and national loss; but rather to meet the situation through greater efficiency in all methods of management, which practice cannot but result iu producing more poultry meat and eggs from the present stock or the present amount from less stock.

Furthermore, It is our sincere belief that those poultry raisers who practise modern methods in management, who adhere to better stock, and who meet intelligently ever-changing conditions of feed and labor, cannot but reap the benefit for this effort. We further believe that America's poultry men and poultry women will be able to meet their national and international obligations, until the close of the war, without seriously sacrificing their financial interests. After this time, it is confidently believed that there will be unprecedented demand for breeding stock and all classes of poultry products from our own and foreign countries. We further believe that at that time the cost of production on account of cheaper feed, labor and equipment will be such that poultrymen will receive a just reward for their courage, sacrifice and loyalty in meeting this our personal and national problem. With each individual poultryman doing his best, the desired results to ourselves and our country, both financially and economically, will be assured.

Be It Further Resolved, That these resolutions be given nationwide publicity through every available means, including the work of the Committee on Publicity appointed at this convention, and that a special committee be appointed by the chair to insure the proper distribution of the same in order to insure confidence among the poultry fraternity.

(Signed) NEW JERSEY STATE POULTRY ASSOCIATION.
HARRY R. LEWIS,
CHAS. WARNER,
Delegates.

Resolution Presented and Passed at the American Poultry Association Convention at Milwaukee, Wisconsin, September 25 to 28, 1917

Presented by the New Jersey State Poultry Association

Whereas, Due to the high prices of feed existing, it has been impossible for the poultrymen of this country to produce the one hundred million pounds of poultry asked by the Special Emergency Committee of the American Poultry Association, but instead, the poultry of the country has been cut down 20 to 25 per cent; and

Whereas, It is imperative, during this crisis, that the production of poultry products be increased in every way, when this can be done in an economical and efficient manner; and

Whereas, The New Jersey State Poultry Association believes that a national campaign could be started, which would call the attention of urban and suburban dwellers to the importance of keeping a few hens, with which to furnish eggs and poultry meat for their own tables; and

Whereas, This means of increasing poultry feed seems to be the most logical method available, due to present shortage of labor, and to the high feed costs; and furthermore, this practice will result in great transportation saving, owing to the fact that the eggs and meat are produced at the point of consumption, and likewise considerable of the feed consumed is derived from purely local sources; therefore,

Be It Resolved, That the American Poultry Association through its Publicity and Promotion Committee, as appointed at this convention, organize and promote a nation-wide campaign to meet this end, through its state branches, the state poultry associations, the Federal Department of Agriculture, the agricultural colleges and experiment stations, the state boards of agriculture, and any other medium available, to explain to the city and suburban dwellers, the necessity and possibility at this time of keeping a few hens, to house, feed and care for them, and how to use economically table scraps and other home products that normally go to waste.

Such a practice would mean cheaper poultry and eggs, as well as a constant high quality, which are two factors worthy of serious consideration. And lastly, during this period of national sacrifice and devotion, the serious consideration of this problem is a patriotic duty, which all owe their Country.

(Signed) H. R. LEWIS,
C. N. WARNER,
Delegates.

The poultry husbandman has devoted some time during the year to the duties of the office of secretary and treasurer of the American Association of Instructors and Investigators in Poultry Husbandry, which office he has held for the past four years. The office of the association is located at the poultry department, and the journal of this association is published at New Brunswick and edited by the writer. This publication, which is issued monthly, has found an important field for service in coordinating poultry activities in the various states and in acting as a medium for the publication of valuable material dealing with research and instruction in poultry husbandry.

Poultry Building Project

Due to the advent of war and the need for service and for concentration of effort upon poultry production, the organized poultry

secure funds for the erection of a suitable building to house the department of poultry husbandry. This was somewhat disappointing, but everyone appreciated that it was the proper action to take. Plans are being made for pushing the project vigorously as soon as the time seems propitious.

Financial Statement

The following is the financial statement covering the cash and credit sales of the department for the year, beginning November 1, 1916, and closing October 31, 1917. These figures show an increase in revenue over the previous year of approximately $1,500, or 30 per cent, and it is anticipated that the revenue for the ensuing year will show a gain of practically 30 per cent over that realized during the past year.

MONTHLY RECEIPTS

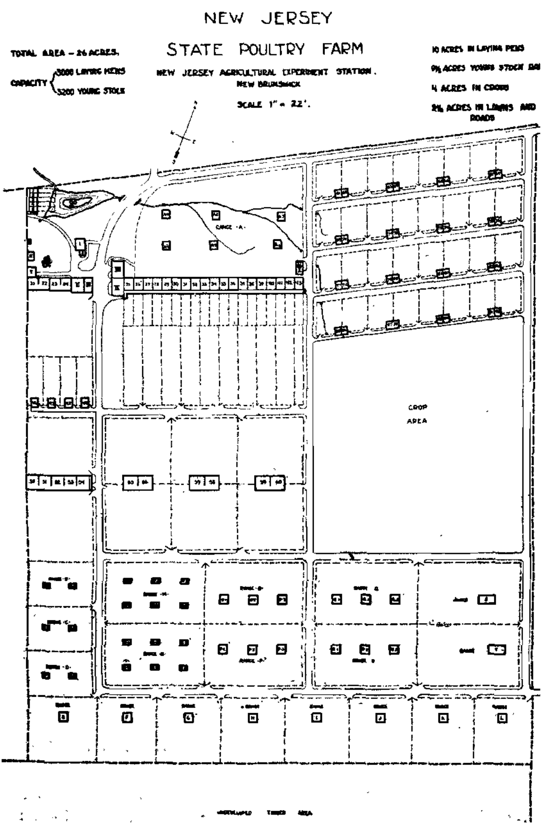
November, 1916, $183.87; December, 1916, $199.46; January, 1917, $306.04; February, 1917, $409.12; March, 1917, $694.89; April, 1917, $636.80; May, 1917, $765.56; June, 1917, $783.61; July, 1917, $657.82; August, 1917, $612.08; September, 1917, $167.30; October, 1917, $450.14; Total, $5,866.69.

In the above statement no effort has been made to show a complete inventory. A list of research projects, the number of birds, and their quarters on the new poultry farm will appear later in this report. It should be appreciated, however, in analyzing the preceding statement, that a material increase has been made during the year in the number of birds and in stock, grown both for research as well as for educational purposes. If this increase in stock were shown as a financial asset, the returns would be considerably increased.

New Poultry Farm

Figure 1 shows the complete layout of the new poultry farm, occupying as it does, 26 acres of land, with a capacity of 3,000 laying hens and approximately 3,200 head of young or growing stock. The area is divided as follows; 10 acres devoted to laying houses and yards, 9½ acres to young stock range, 4 acres to crops and 2½ acres to lawns and roads. In connection with the new poultry

FIG. 1.—Plan of the New Jersey State Poultry Farm.



farm, an 1,100-bird commercial poultry plant is being operated under ideal practical conditions. Complete records of cost of production, labor, etc., are being kept, and it is hoped that this study will result in accurate data pertaining to the possibilities of this branch of the work. A descriptive key to the map of the poultry farm appears herewith.

KEY TO MAP OF POULTRY FARM

1. Residence and office, root storage in cellar.
2. Egg room.
3. Lavatory.
4. Corn crib.
5. Killing house.
6. Wagon and tool shed.
7. Stable and hay storage.
8. Grain storage.
9. Feed house, mixed rations.
10. Manure house.
11. Incinerator.

		Combined Capacity
Pens 1 to 5	Duck house, 16x50 feet	100
Pens 21 to 22	Incomplete	150
Pens 23 to 24	Shed roof laying house, 14x40 feet	150
Pens 25 to 42	Shed roof long laying house, 16x228 feet	950
Pens 46 to 49	Four two-third span roof colony cockerel houses, each house 12 feet deep and 10 feet long	120
Pens 50 to 54	Five unit multiple unit laying houses, 20x106 feet (the six feet being feed room)	500
Pens 55 to 60	Three double pen multiple unit laying houses, each house 20x40 feet	600
Pens 60 to 92	Sixteen double pen breeding houses, each house 10x12 feet	490

Range Houses.		Combined Capacity
A1 to A6	6 Colony houses 6x8 feet	800
B1 and 2, C1 and 2, D1 and 2	6 Colony houses 4x6 feet	150
E to L Incl.	8 Colony houses 6x8 feet	800
M1 to M6	6 Colony houses 4x6 feet	150
N1 to N6	6 Colony houses 4x6 feet	150
O1 to 3, P1 to 3, Q1 to 3, R1 to 3	12 Colony houses 6x8 feet	1200
S and T	2 Colony houses 10x20 feet	400
Cockerel range just acquired;	4 houses 6x8 feet	400

It is believed that the above data will be of interest to those concerned in erecting poultry plants or parts of poultry plants. Plate I

PLATE 1

anorama view of a Portion of the Laying Houses on the New Poultry Farm.

Beets are growing in the foreground and winter grain has just been seeded in the large field just

The laying experimental feeding house is shown in the center of the picture.

project on the state poultry farm.

Note the color marks on the plumage of the Leghorns, which method s used to designate the different birds, and thus avoid mixing of flocks.

Note double pen breeding houses in distance.

PLATE II.

FIG. 1.—The 100-foot multiple unit laying house, containing 500 pullets.

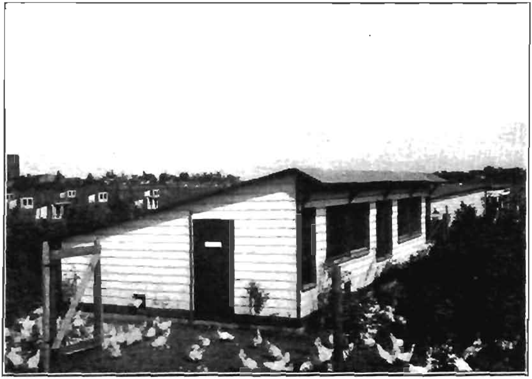


FIG. 2.—Two of the 20x40-foot multiple unit laying houses, containing the breeding birds.

PLATE III

The grain elevator and feed storage headquarters on the new poultry farm.

The stacked wheat and oat-straw was grown on the farm.

shows a view of the poultry farm and plans of the multiple unit house, which is used for housing the commercial layers.

III

EXPERIMENTAL WORK

Because of the limited space which is allotted to this report and the length of time required for publication, it is deemed wise to describe the research problems in only a very brief way, stating conclusions rather than showing all details of each project. A special effort has been made to dwell more on the practical problems concerning poultry production, as it is believed that these are of special significance to the poultry producer at the present time.

In discussing the research activities of the department, it has been decided to group them according to the nature of the problems under investigation. Before attempting to discuss any special group of problems the following list of projects which are under investigation will be of interest. After each is noted the date at which the project was started. The major projects are primarily those which are designed to run over a considerable period of years and which constitute some of the more fundamental problems, while the minor projects are more in the nature of laboratory tests of short duration, the results of such minor studies having immediate practical benefit. The research activities are so organized that various members of the department are especially concerned with the details of certain projects. All of these are outlined by and under the personal supervision of the poultry husbandman. Reports regarding the progress of each project are made at monthly staff meetings and filed for reference with the original project outline.

Outline of Research Work in the Department of Poultry Husbandry

Major Projects	Group 1	Date Begun
A.	**Breeding Problems and Inheritance Studies with Poultry.**	
A1—17.	*Fecundity.* "The distribution and inheritance of fecundity in the domestic fowl"	November, 1911
A2—17.	*Pigmentation.* "The inheritance of color pigment in the domestic fowl"	November, 1911
A3—17.	*Egg Shell Color.* "Variations and inheritance of egg-shell color in the domestic fowl"	November, 1914

A4—17.	*Sequence of Sexes.* "The sequence of sex in the domestic fowl and controlling factors"	November, 1916
A5—17.	*Strain Test.* "A strain test of the Single Comb White Leghorn breed of fowls"	April, 1916
B.	**Incubation Problems and Baby Chick Production.**	
B1—17.	"The amount and causes of embryo mortality"	January, 1916
C.	**Nutrition Studies with Poultry.**	
C1—17.	Animal concentrates as protein carriers	November, 1917
D.	**Poultry Management Investigations.**	
D1—17.	Effect of time of hatch upon moult and seasonable production	January, 1917
D2—17.	Commercial poultry flock management	November, 1917
D3—17.	Standard unit poultry plant	November, 1915
D4—17.	The elaboration of growth and production standard for poultry	November, 1917
E.	**Factors Affecting the Efficiency of Poultry Research Methods.**	
E1—17.	The error factor in experimental analysis	November, 1916
Minor Projects.		
Z.	**Factors Affecting the Preparation, Marketing and Distribution of Poultry Products.**	
Z1—17.	The home preservation of eggs	April, 1912
Z2—17.	Seasonable price variations at New York market for poultry products	November, 1916
Y.	**Problems in Marketing Poultry Products.**	
Y1—17.	Types and breeds as affecting economic capon production	November, 1916
Y2—17.	Season as a factor in broiler production	November, 1916
X.	**Poultry Disease Investigations.**	
X1—17.	Disease investigations concerning the prevalence and distribution of poultry diseases in New Jersey	November, 1911

Major Projects. **Group 2**

Conducted at the Vineland International Egg Laying and Breeding Contest

V. A1—17.	Amount, distribution and inheritance of fecundity in domestic fowls	November, 1916
V. A2—17.	External characters as indicative of a fowl's producing ability	November, 1916
V. B1—17.	Incubation problems. Same as B1—17	February, 1918
V. C1—17.	Nutrition studies, amount and cost of food consumption and its relation to fecundity	November, 1916

In the following discussion of the progress of experimental work it is the plan to mention the nature of the study, its progress, and

A.—BREEDING PROBLEMS

1. *The Distribution and Inheritance of Fecundity in the Domestic Fowl*

The fecundity investigations which have been under way during the past few years have been conducted primarily with the idea of developing families of Single Comb White Leghorns and Barred Plymouth Rocks, which would be especially productive and which could be used as a basis of the propagation of stock, more especially cockerels for distribution throughout the state. During the past year this work has progressed very satisfactorily. The department has on range at present about three hundred pedigree cockerels of high fecundity parentage, which will be disposed of at cost during the coming winter for use in breeding pens next spring. Of even greater interest is the progress which is being made in the increased productivity of future generations of daughters. No effort will be made in this report to show in detail the progress made other than to state that the Belle of Jersey family which has been carefully conserved and developed has continued to produce phenomenal layers; 20 pullets are being trap-nested from this family at the present time and have made a splendid start during the past month. Certain individuals in particular show a remarkably long cycle; 2 pullets have laid the first twelve days in November without a miss. This is a peculiar cycle for Leghorns, which usually have a shorter cycle with frequent rhythm. If the pullets from the various high-fecundity females make a satisfactory showing this winter, it will possibly be the plan of the department to enter a pen of representative females at the more important egg-laying contests during 1918, at which time the records of breeding and performance will be published in bulletin form. The work with Barred Plymouth Rocks has progressed very satisfactorily, one female having been developed which produced, consistently, between 200 and 240 eggs. If these pullets, at present under the trap nest, show up as well as they have in the past, this variety also will possibly be tested out at egg-laying contests.

2. Inheritance of Color Pigmentation in the Domestic Fowl

As mentioned in last year's report, this project, which is designed to secure data pertaining to the mode of inheritance of color pigmen-

tation as shown in plumage pattern, in shank, in eye, in skin and in egg-shell color, is progressing satisfactorily after a complete reorganization last year. The work is being promoted by cross-breeding and making reciprocal matings of Black Langshans and White Leghorns, and Black Hamburgs and White Leghorns. F^1 and F^2 generations of these matings are now on range and will be studied during the coming winter in order to determine the mode of inheritance of the characteristics under observation. As mentioned in last year's report, the presence or absence of inhibiting factors for pigmentation and barring were being tested in 14 different and supposedly unrelated strains of Single Comb White Leghorns. The cockerels for this work were secured from the strain test which was reported last year. It may be stated at this time that all progeny from these cockerels, the mother in every instance being a Black Langshan hen, show no trace of the barring pattern. This leads us to assume that all of the males of the strains under test possess the characteristic dominant white of the Leghorn variety, and possess the inhibiting factor for the barring character. At this writing reports have not been received from Dr. Philip B. Hadley, of the Rhode Island Experiment Station, who is duplicating the work and cooperating with the department, cockerels for his test being provided by this department. Detailed findings regarding the F^1 generation and the reciprocal crosses made in 1916 will soon be published in a technical journal.

3. Variations and Inheritance of Egg-Shell Color in the Domestic Fowl

During the past year the research project dealing with the shell color of eggs produced by Barred Plymouth Rocks and Light Brahmas, as representatives of brown-shell egg-producing breeds, has been continued and somewhat enlarged. During the previous two years a great many birds had been trap-nested and closely studied with regard to egg-shell color, primarily to ascertain the general behavior of the average birds in a flock as to constancy or uniformity in the production of evenly-colored eggs. There were two principal reasons why this information was wanted.

A. Many claims have been made that it is possible to identify the eggs of individual hens by becoming familiar with the color of egg produced by each individual. This method of obtaining the egg production of individual hens rests upon the assumption that every hen

produces eggs of the same shade and type of color each laying day. If this assumption were proven absolutely reliable and true, it would be possible, by trap-nesting for a short time, to select a flock of females that would produce uniformly-colored eggs each day. Then, the frequent complaint that it is difficult to put up fancy cartons of uniformly-colored brown eggs for particular trade could soon be eliminated. It has often been noticed in large lots of brown-shelled eggs that there are many varying shades of brown color, and many variations of color pattern. Contrary to this opinion, breeders of brown-shell egg birds have expressed the belief that individual birds do not always produce eggs of the same color, but that so much variation is found that individual birds cannot be accurately measured as to egg production by the color or pattern of shell. Therefore, one of the first objects of this preliminary observation was necessarily to obtain considerable accurate data on this particular question.

B. As a second reason for the accumulation of data concerning the nature of shell color, it was desired to find individuals who produced eggs of the same, uniform color or shade or pattern consecutively, and also individuals that varied widely, either in regular cycle or without any apparent regularity. This was primarily for the purpose of selecting individual hens which could be used in a project, the main object of which was the study of the behavior of this characteristic as a possible transmissible character from generation to generation. In other words, the question as to whether or not the color of shell is a genetic character that is transmitted to offspring, or a characteristic that is controlled by other factors, such as body condition, feed, etc., was to be studied.

Previous to the year just completed, all eggs produced by over one hundred Barred Plymouth Rock and Light Brahma pullets and hens were marked, when collected, with the date, hen and pen number, so that the identity of each egg and the time laid was known when the eggs were graded. A standard of egg-shell colors was used, as described in last year's annual report. By charting down to each individual pullet or hen the shade of color shown in each egg produced, and in the order produced, the exact information desired was obtained. The analysis of this mass of data has taken much time, and has shown some very interesting results. Principal among the observations made upon looking over these records was the fact *that over 75 per cent of the individuals of each breed showed* a tendency to vary very widely in the production of egg-shell color. These individual hens did not produce eggs of the same shade, and in many cases, of the same pattern, during their laying seasons. No apparent cycles were noted, but the color of the egg shells, on the other hand, seemed to vary in no particular order. Many individual hens would produce some dark brown eggs with no spots of irregular color on certain days, while on other days their eggs were very light brown, or perhaps spotted with blotches of dark brown,

or even white color. In some instances individuals produced eggs of absolutely the same uniform color throughout the period in which their eggs were graded. An example of such a bird may be found in Barred Plymouth Rock hen No. 54, who is now in her third year, and who has never produced an egg which was other than No. 19, a dark, unspotted, reddish brown, in color. It is interesting to know that this hen produced considerably over 200 eggs during the first, or pullet, year. Another example may be found in another Barred Plymouth Rock hen, No. 50, who has never produced an egg other than No. 13 in color, which is a light, pinkish brown, undercolor, with a large sprinkling of white spots. Other birds with almost equally uniform habits of production in regard to shell color have been found during the three years of observation.

From the original flocks several of these types have been selected and placed in special matings. Along with them several typical individuals, whose eggs always varied widely, have been selected and kept as breeders. During the past year 8 pens, four of Barred Plymouth Rocks and four of Light Brahmas, each containing 8 females, have been maintained and their eggs carefully graded. With these females good cockerels of each breed, respectively, were mated. In some instances the cockerels were sons of mother hens whose behavior with regard to egg-shell color production was unknown. In such instances, the young birds raised during the past summer are extremely interesting and valuable. In making up the breeding pens for the coming year on November 1, 1917, all cockerels used will be known, as well as many new pullets; in another inheritance, and more with each succeeding generation. Work of this kind is necessarily slow in showing definite results. Up to the present time it is not felt that any definite conclusions can be suggested other than that undoubtedly very often individual hens in the average flock do vary in the color of egg produced.

This research project is, perhaps, only just begun. The development of the line upon which we are now working may very possibly suggest other lines of experimentation for later solution. It is of interest from many standpoints. From the scientific standpoint the question as to the actual cause of variation in egg-shell color and the possibility of its being an inherited character, or the nature of controlling it is of great interest. From the practical poultry

raisers' viewpoint, it is interesting because the study may result in some suggestions which will aid him in producing brown eggs of greater uniformity of shade than has heretofore been thought possible. The coming year's work in the project will be of especial interest and value because of the greater definiteness which can characterize the work. The preliminary work, involving large numbers of individuals, has largely been replaced by a more detailed study of certain small numbers of individuals whose past performance in this regard is known and whose progeny are at hand for observation.

4. The Sequence of Sex in the Domestic Fowl and Controlling Factors

Commercial poultrymen are much concerned regarding the proportion of sex in each season's hatch. During some seasons there seems to be a preponderance of pullets, and at other seasons an excess of cockerels. The chicks from certain individual hens which are being trap-nested and the eggs pedigree-hatched seem to run in some instances to pullets and in other instances to cockerels, while in most cases there seems to be somewhere near a balance between the two sexes. No effort has been made to determine the sequence of sex from individual hens, and any possible factors which may affect this sequence. This project is a new one which is just being started November 1, 1917, and will have for its object the determination and sequence of sex in chicks from individual hens and the possible correlation of certain factors which may in any way affect sex. Uniform pens of maturing pullets are being used for the work. Every egg laid will be incubated. The chicks will be killed at hatching time and the sex determination made by biological examination. It is hoped that this work will bring out certain interesting factors which have been unnoticed to date.

5. A Strain Test of the Single Comb White Leghorn Breed of Fowls

The strain test described in last year's report has progressed satisfactorily, pens of pullets from each strain having been trap-nested throughout the past year. Some remarkably high-producing birds have appeared and likewise some very low producers have made their appearance. Eggs will be hatched from each of these

strains in the spring and the pullets will take the place of the present hens during the next laying season. It is not proposed to publish any of the data regarding this project at the present time, but after a few years' progress a complete bulletin will be issued dealing not only with the performance of the various strains in so far as egg production is concerned, but with the breeding as well.

B.—INCUBATION PROBLEMS

1. The Amount and Causes of Embryo Mortality

During the past winter, a project was started entitled "The Amount and Causes of Embryo Mortality." The department has from time to time made certain observations on this problem, but never in an organized way. The object of this project is to determine some of the factors affecting the mortality of chick embryos, to determine the economic loss due to the prevalence of this mortality, and to evolve means of controlling it. Although the project has not, as yet, been completed, some interesting results have been obtained, and a few of them are recorded below. It will be noticed in the following experiments that the percentages of hatch are low. This is no doubt due to the fact that the parent birds did not have the privileges of free runs, but were shut in the laying pens all winter and spring.

HOLDING EXPERIMENT—An experiment to study the effect upon the vitality of the embryo of high, low and medium temperatures during the period of holding, before placing in incubator, was run in the following manner. Nine hundred eggs, selected for color and shape, were put in three ordinary egg crates, 300 in a crate. One crate was held at a temperature of 45 to 50° F., another at a temperature of 60 to 65° F., and the third at a temperature of 75 to 80° F. The eggs were kept at these temperatures for one week before placing in the incubator, and received a quarter of a turn each day to prevent the yolk from sticking to the shell. White Leghorn eggs were used, of the same age, and laid by the same pens.

At the expiration of a week, the eggs were placed in a Candee Mammoth Incubator, 75 in a tray, 300 in a section, only eggs from the same crate being put in the same section. Thus those held at one temperature were kept separate from those held at another temperature. All eggs received the same treatment after being placed in the machine; a uniform temperature of 103° F. was kept

throughout the hatch and the eggs were sprinkled once a day with luke-warm water from the fifteenth to the nineteenth day, inclusive. The eggs were weighed four times during the hatch to determine the loss of weight and evaporation. The weighing periods were the first, seventh, thirteenth and nineteenth days. The chicks also were weighed as soon as they were dried off and before they had been given any feed.

The results obtained were interesting and uniform throughout the experiment. The eggs which were held at a low temperature, 45 to 50°, hatched the best, giving a 57 per cent hatch of all eggs set and 59.6 per cent of fertile eggs; those which were held at a medium temperature, 60 to 65°, hatched the next best, giving a 51.3 per cent hatch of all eggs set and 53.7 per cent of fertile eggs; those which were held at a high temperature, 75 to 80°, hatched the poorest, giving a 33.7 per cent hatch of all eggs set and 36.6 per cent of fertile eggs. These figures show a difference of 18.5 per cent between the eggs held at a high temperature and those held at a medium temperature, and 5.9 per cent between those held at a medium temperature and those held at a low temperature, while they show a difference of 24.4 per cent between the eggs held at a high temperature and those held at a low temperature. Table 1 shows the figures more plainly.

Table 1

Effect of Holding Eggs at Different Temperatures on Hatching

Temperature at which eggs were held	Per cent hatch of total eggs set	Per cent hatch of fertile eggs
45°-50° F.	57.0	59.6
60°-65° F.	51.3	53.7
75°-80° F.	33.7	36.6

On the morning of the twenty-first day a number of the chicks had hatched from the eggs which had been held at a low temperature, while from the eggs which had been held at a medium temperature, only a few had hatched, and from the eggs which had been held at a high temperature only one chick had hatched. The hatch was not completed, because of the slowness with which the latter group hatched, until noon of the twenty-second day. As to the average weight of each chick, there was very little difference, at least not enough to warrant any definite conclusions, those from the

eggs held at the high temperature averaging 1,326 ounces, and those from the eggs held at medium temperature averaging 1,333 ounces.

The results obtained from weighing the eggs were what we would naturally expect. When put into the incubator, the eggs held at a low temperature weighed the most, and those held at a high temperature weighed the least. The weights were 40 pounds (held at low temperature), 39 pounds 2 ounces (held at medium temperature), and 38 pounds 3½ ounces (held at high temperature). The eggs held at the higher temperatures lost more weight because of the greater evaporation of the moisture. A summary of the weights taken during the hatch shows that the eggs which had been held at a low temperature lost, during the entire hatch, 103.5 ounces, while of the other two lots of eggs, each lost about 73 ounces. These latter two sets of eggs (held at high and medium temperatures) had lost, while they were being kept for incubation, practically all the weight they could afford to lose. Naturally, they could not lose more weight and still have material left of a proper concentration for the embryo to assimilate, while the other eggs (those held at a low temperature) not having been exposed to conditions favorable for rapid evaporation of moisture, maintained their weight until placed in the machine, and there, under normal development, lost weight due to evaporation incident to incubation. The amounts lost from evaporation are shown in Table 2.

Table 2

Loss of Weight by Evaporation in Eggs Held at Different Temperatures

Temperature at which held previous to incubation	Lost first 6 days (oz.)	Lost second 6 days (oz.)	Lost third 6 days (oz.)	Total loss 13th day (oz.)	Total loss 19th day (oz.)
45°-50° F.	44.5	43.0	16.0	87.5	103.5
60°-65° F.	26.0	27.5	19.0	53.5	72.5
75°-80° F.	31.5	29.5	12.0	61.0	73.0

The results of holding the eggs at the different temperatures may be seen not only in the percentage of hatch and loss of weight due to evaporation, but also in the number of eggs removed from the incnbator at candling, shown in Table 3.

It will be readily seen that those previously held at a low temperature had the fewest removed, those held at a medium temperature had a few more, and those held at a high temperature had the

most removed. In the case of the latter group, the germs had undoubtedly started to develop and had been checked, thus accounting for the large number of dead germs, while other germs were so weakened that they probably developed too slightly to be noticed

Table 3

Eggs Removed at Candling in Holding Experiment

	Held at 45°-50° F.	Held at 60°-65° F.	Held at 75°-80° F.
Infertile	13	13	24
Dead at 7th day	25	37	73
Dead at 14th day	11	11	17
Total	49	61	114

and passed the test as infertile, thus accounting for the increase in infertile eggs over the other two lots.

Figure 2 shows a summary of the results obtained in this experiment.

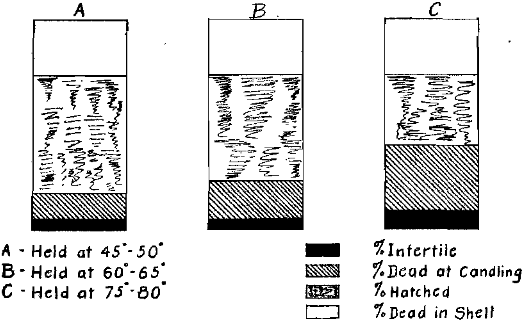


Fig. 2.—Diagram showing results of holding experiment.

The above results would seem to show:

1. That a higher percentage of hatch is obtained when eggs are held at a low temperature.

2. That eggs lose weight from evaporation of moisture when held at a medium or high temperature.
3. That when eggs are held at a high temperature the germs are so weakened that a considerable number die during the first seven days of incubation.
5. That eggs when held for incubation should be kept at a temperature not higher than 50° F., and could be kept with safety at a slightly lower temperature.

COOLING EXPERIMENT—An experiment was run on the length of time of cooling eggs during incubation. The object of this experiment was to study the effect upon the percentage of hatch and upon the vitality of the chick of various degrees of cooling during incubation.

The eggs selected were all good-sized, clean, white eggs, free from tints, laid by the same pens of Single Comb White Leghorns. They were put in the same incubator, of the Candee Mammoth type, filling one side of the machine, or five sections. Each section of this machine holds 300 eggs, but in order not to crowd them and to have the best conditions possible, 288 were placed in each section. Two sections of these eggs were cooled until the eggs were cold, morning and night; two sections were not cooled at all, not being taken out of the machine except for turning and then put right back; one section was cooled until the eggs were nearly cold in the morning and received no cooling at night. Thus, we have three degrees of cooling: extreme cooling, medium cooling, and no cooling. All other conditions during incubation were the same. The eggs were sprinkled with luke-warm water once a day from the 15th to the 19th day, inclusive. They were arranged in the machine in the following manner:

Section 1—Eggs cooled until cold.
Section 2—Eggs not cooled at all.
Section 3—Eggs receiving medium cooling.
Section 4—Eggs not cooled at all.
Section 5—Eggs cooled until cold.

The results as to percentage of hatch are given in Table 4.

It can be seen from the foregoing table that there was not a great deal of difference in the percentage of hatch. The eggs that received a medium cooling hatched the best, those that received extreme cooling were next in percentage of hatch, and those that received no cooling hatched the poorest. This can more easily be

seen when the results of sections 1 and 5 are added and averaged and sections 2 and 4 added and averaged, as shown in Table 5.

Based on the percentage of hatch from fertile eggs, these results show a difference of only 0.3 per cent between the sections that received no cooling and those that received extreme cooling, and a difference of 3.8 per cent between sections that received extreme cooling and the section that received medium cooling, making a difference of 4.1 per cent between sections receiving no cooling and the section which received medium cooling.

Table 4

Percentage of Hatch in Cooling Experiment

	Per cent of total eggs set	Per cent of fertile eggs
Section 1	69.1	74.5
Section 2	68.8	73.6
Section 3	68.8	74.7
Section 4	62.2	67.5
Section 5	64.2	67.3

Table 5

Average Percentage of Hatch in Cooling Experiment

	Per cent of total eggs set	Per cent of fertile eggs
Sections 1 and 5........	66.7	70.9
Sections 2 and 4........	65.5	70.6
Section 3	68.8	74.7

Notes taken at the time of hatching show that in sections 2 and 4, containing eggs which received no cooling, 15 chicks were hatched and a number of eggs pipped at noon of the 19th day. A number were hatched by night of the same day and a large number on the 20th day. By the morning of the 21st day all chicks in both sections 2 and 4 were hatched. In the section that received medium cooling, section 3, one egg was pipped the 19th day and a few chicks hatched the 20th day. By night of the 21st day, all chicks in this section were hatched. However, the eggs in sections 1 and 5 were much delayed; there were a number pipped by the end of the 20th day, but none hatched until the morning of the 21st day and then

only a few in one section. In section 5 none hatched at all on the 21st day, and it was not until the close of the 22nd day that all were completely hatched in these two sections.

The chicks hatched in these last two sections, however, were all large, healthy chicks and weighed more than those hatched in the other sections. Weights were taken of all chicks before they had received any feed. Table 6 shows the average weight per chick from each section.

Table 6

Average Weight per Chick in Cooling Experiment

Average weight per chick (oz.)

	All Sections	Average, Sections 2 and 4	Average, Sections 1 and 5
Section 1	1.344		
Section 2	1.243		
Section 3	1.318	1.27	1.348
Section 4	1.296		
Section 5	1.351		

It can readily be seen that the weights of the chicks vary in direct proportion to the length of time the eggs are cooled during incubation, the average weight per chick hatched from eggs receiving no cooling being 1.27 ounces, or .048 ounce less than the average weight per chick hatched from eggs receiving medium cooling, which was 1.318 ounces. This weight, in turn, is .03 ounce less than the average weight of chicks hatched from eggs receiving extreme cooling, viz., 1.348 ounces.

As to the results of candling during the hatch, not a great deal can be said, as there is so little variation. Table 7 shows the number removed at each candling.

Table 7

Eggs Removed at Candling in Cooling Experiment

	Section 1	Section 2	Section 3	Section 4	Section 5
Infertile	21	19	23	23	13
Dead at 7th day........	17	15	12	11	11
Dead at 14th day.......	12	8	9	16	14
Vigorous chicks.......	199	198	198	179	185

Table 8 shows the same results expressed in percentages.

Table 8

Percentage of Eggs Removed at Candling in Cooling Experiment

	Infertile	Dead
Section 1	7.2	10.1
Section 2	6.5	7.9
Section 3	7.9	7.2
Section 4	7.9	9.4
Section 5	4.5	8.7
Average per Treatment.		
Sections 1 and 5	5.9	9.4
Section 3	7.9	7.2
Sections 2 and 4	7.2	8.7

There is not sufficient variation from which any definite conclusions can be drawn concerning the effect of various periods of cooling on the percentage of infertile eggs and dead germs.

The above experiment was repeated, with brown-shelled eggs in place of white-shelled eggs. No section was run corresponding to section 3, however, because a sufficient number of Barred Plymouth Rock eggs of the same age, from the same pens, could not be obtained. The experiment was run at the same time as the above experiment, in the opposite side of the same incubator. Sections 6 and 8 contained eggs which received extreme cooling, and sections 7 and 9 eggs which received no cooling. The same method of cooling was used as in the above experiment. Three sections of eggs, sections 6, 7 and 8, contained 288 eggs each, and section 9 contained 303, as these eggs were a trifle smaller than the others.

The results as to percentage of hatch do not show any decided advantage of one over the other, although the sections receiving no cooling had 6.1 per cent higher hatch than the sections receiving extreme cooling. It will be remembered that while with white eggs there was very little difference in the per cent of hatch, the result was in favor of extreme cooling as compared with no cooling.

Similar results were obtained as to weights of chicks. The chicks hatched from eggs which received extreme cooling averaged heavier than those from eggs which were not cooled (Table 9).

The average weight of chicks hatched from the eggs which received extreme cooling was 1.309 ounces, while that of chicks from the eggs which were not cooled was 1.198 ounces, a difference of 0.111 ounce in favor of the former.

Table 9

Average Weight per Chick in Cooling Experiment

	Average weight per chick (oz.)		
	All Sections	Average, Sections 7 and 9	Average, Sections 6 and 8
Section 6	1.285		
Section 7	1.209		
Section 8	1.334	1.198	1.309
Section 9	1.187		

Similar results were obtained as in the above experiment as to time of hatching. The eggs which received no cooling began to pip the 19th day and hatch the 20th day, while those which received extreme cooling pipped the 21st day and hatched the 22nd day.

A summary of results obtained in this experiment show:

1. That eggs receiving extreme cooling hatch heavier chicks than eggs receiving a medium amount of cooling and eggs receiving no cooling, and that the average weight per chick increases with the amount of cooling the eggs receive during incubation.
2. That there is very little difference in the percentage of hatch due to various periods of time of cooling eggs during incubation.
3. That eggs receiving extreme cooling hatch a day later, and eggs receiving no cooling hatch a day earlier than eggs receiving a medium amount of cooling.
4. That more cooling during incubation should be practised than has been recommended in the past, since the percentage of hatch is not decreased, and healthier chicks are hatched.

C.—NUTRITION STUDIES WITH POULTRY

1. Animal Concentrates as Protein Carriers

Appreciating the importance of animal constituents in the poultry ration, and also appreciating the extremely rapid rise in the market price of meat scrap, which heretofore has been the main animal concentrate used in compounding poultry rations, it was determined to inaugurate a rather complete test, studying the efficiency of certain animal carriers of protein. The project as outlined and operated includes 480 Single Comb White Leghorn pullets, divided into

12 flocks of 40 birds each. The following products are being tested: meat scrap, digester tankage, buttermilk powder, fish scrap, skim milk and semi-solid buttermilk. Meat scrap is used as a check and is added to the standard basal mash at the rate of 20 per cent. Such amounts of the other concentrates are being added to the basal mash as to bring the total protein content to that of the 20 per cent meat scrap mash. All pens are being fed a standard grain ration and duplicate pens are being fed all these rations in order to avoid, as far as possible, the individuality factor. The study will include a determination of the composition and availability of the nutrients carried by each product, together with the general effect of their use upon the health and productivity of the birds so fed. The relative commercial possibilities of each product will be studied in so far as efficiency, supply, price and quality are concerned. To date, the birds in this project are making a very satisfactory production, and it is anticipated that the results will show more accurately the relative possibilities of the different foodstuffs under investigation.

D.—POULTRY MANAGEMENT INVESTIGATIONS

1. Effect of Time of Hatch Upon Moult and Seasonable Production

The poultry department during the past years has encouraged early hatching. Numerous minor experiments have been run to determine the relative possibilities of February-hatched pullets versus late-hatched pullets. Reports of this work have been published from time to time. Being an important commercial problem, it was decided to maintain a more elaborate series of studies concerning it. This project was started January 1, 1917, and consists of a study of a uniform pen of pullets hatched on each of the following dates: January 1, February 1, March 1, April 1, May 1 and June 1. These pullets are now in laying houses and being trapnested. Careful data are being kept pertaining to the moult, amount of production, food consumption, etc., in order to determine the relative cost and profit and general behavior of each of these groups of birds; the only varying factor being time of hatch. This project will be fully reported on next year.

2. Commercial Poultry Flock Management

As previously mentioned, the new poultry farm is of such size, and so equipped that a complete commercial poultry plant is being

operated in addition to the equipment set aside for detailed research work. This commercial poultry flock management project is organized and designed to study all details of commercial poultry production, under ideal conditions of management, in order to determine the actual possibilities and financial returns from such type of poultry husbandry.

In this project an 1100-bird plant is to be the unit of size. Single Comb White Leghorns have been determined upon as the breed best suited for the work. Pens 50 to 60, inclusive, on the new poultry farm, have been set aside for the exclusive use of this project. The commercial flock will be divided into the following parts, and housed accordingly: Pens 50 to 54, inclusive, which constitute the long 100-foot multiple unit laying house, will contain 500 pullets which were hatched May 22 and brooded in this house. Pens 55, 56, 59 and 60 contain a total of 400 selected yearlings which will be mated to cockerels in the spring and used as the main part of the breeding flock. Pens 57 and 58 contain 200 February-hatched pullets which will be mated next spring and also used for breeding. This distribution of the flocks will make, for purposes of study, a commercial poultry farm of 1,100 birds, of which 600 are breeders and 500 are pullets. The latter will be unmated and will be used in the production of infertile table eggs.

PLAN OF STUDY—This project naturally divides itself into certain definite lines of study.

1. Amount and distribution of egg production from each flock and from the total unit.
2. Food consumed from each flock and from the total unit.
3. Amount and cost of labor required to care for the total flocks.
4. Detailed sources and amounts of revenue from the project, including table eggs, hatching eggs, stock, meat and manure.

The project will be continued each year and will be conducted along purely commercial lines, the work being especially designed to be of benefit to commercial egg farmers, who exist in large numbers in New Jersey.

3. Standard Unit Poultry Plant

The securing of statistical data by means of farm surveys and the standardization of various phases of poultry management have

progressed very satisfactorily during the past year. The department has conducted a survey with the cooperation of one of the senior students, Mr. Irving Troll, on some of the large commercial breeding farms. A table showing the results of this survey appears below. The department has also cooperated with the department of agronomy and of the Experiment Station in making poultry farm surveys of over 150 specialized egg farms in the leading poultry centers of the state. These surveys were made by Mr. A. G. Waller under the immediate supervision of Prof. Frank App, agronomist. A preliminary report of the survey was published in the October "Hints to Poultrymen," and it is hoped that a complete bulletin dealing with the survey will appear shortly. Interested readers are referred to the report of the department of agronomy and farm management appearing in this volume (p. 318) for preliminary observations dealing with these poultry surveys. The full tabulated report of the poultry survey of breeding farms made by the poultry department through the cooperation of Mr. Troll follows.

Survey of Fourteen Poultry Breeding Farms—The primary objects of the owners on the fourteen farms which were studied was the production of market eggs and the sale of hatching eggs, breeding stock and baby chicks. These can be especially designed as breeding establishments, a large proportion of the revenue being derived from stock sales.

It is not the purpose of this report to go into detail regarding all problems investigated, but rather simply to enumerate a few of the more important results as they relate to the commercial possibilities of this type of farming, and as they are concerned with the deduction of a hypothetical or standard farm of definite size. The study was made by sending to each cooperator detailed blanks which were the regular poultry survey blanks of this department. This survey sheet includes a complete inventory of the farm, the farm rotation, the amount and use of the land, all operating charges in detail, and total revenue, including the sources. Also numerous individual questions were asked concerning details of management, including rations used, character of labor, advertising, etc.

Table 10 gives the average figures for the 14 forms conveyed.

It is not necessary to review the above figures in detail, as they are self-evident and self-explanatory. It must be appreciated that these figures are for the year 1915-1916. Of considerable interest and significance is the effect of the number of birds kept by these

respective owners, as it affects the revenue and operating charges and also as it affects the labor income.

Table 10

Average Figures Obtained in Survey of 14 Poultry Farms

Investment in buildings	$5,824.18
Value of birds	$2,166.54
Investment in equipment	$1,221.71
Operating charges	$3,427.76
Revenue	$7,210.42
Labor income*	$2,997.41
Total number of laying birds	1,337
Total number of pullets	862
Total number of hens	475
Total number of males	83
Average production per bird	134
Yearly mortality	6.1 per cent
Cost of feed per bird	$1.745
Size of farm	23.8 acres
Average labor income per bird (excluding males)	$2.24
Average labor income per bird (including males)	$2.11
Average farm income	$3,782.66

Table 11

Data of 14 Poultry Farms Classified in Three Groups According to the Number of Birds Kept

	Less than 1,000 birds	1,000 to 2,000 birds	More than 2,000 birds
Investment in buildings	$3,765.25	$6,635.01	$8,040.00
Investment in equipment	$815.75	$987.18	$2,331.00
Value of birds	$1,320.12	$2,430.50	$3,200.00
Operating charges	$1,791.72	$4,441.20	$6,666.25
Income or revenue	$3,187.87	$8,566.95	$11,863.82
Labor income	$660.12	$3,191.23	$9,605.60
Cost of feed per bird	$1.66	$1.87	$1.50
Production per bird	134 eggs	145 eggs	125 eggs
Mortality	7 per cent	6 per cent	7 per cent

Table 11 shows these 14 farms divided into 3 groups, namely, those keeping less than 1000 birds, those keeping 1000 to 2000 birds, and those keeping over 2000 birds. A comparison is given of the average figures for each group.

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*Labor income as used here and in the following table means the net profit to the farmer after all operating charges are paid, plus the interest on the investment at 5 per cent.

In the above table it is interesting to note first the consistent rise in all items of expense and income as the number of birds increases, and it is of special interest to note the material rise in the labor income. It should be stated that the farms which exceed the 2000-bird group represent some of the largest and best managed commercial breeding establishments in the East. It should be noted that the egg production per bird is not exceptionally high, nor are the feed costs per bird. The variation in this last figure is due in large part to the different methods employed in buying feed and the fact that much of the feed on the larger farms is raised on the farm, and therefore charged up at wholesale market prices.

Coming now to the immediate purpose of this study, namely, to evolve a hypothetical or average farm of this type, let us consider for a moment table 12, which shows the above surveys worked out on the basis of a standardized farm of 1000 birds. What should we expect from such an establishment?

Table 12

Hypothetical or Average Figures for Standardized Commercial Breeding Farm of 1000 Birds

Commerical Breeding Farm of 1,000 Birds

Investment in buildings	$4,368.14
Investment in equipment	$916.28
Value of birds	$1,624.91
Operating charges	$2,570.82
Revenue	$5,407.82
Labor income	$2,247.06
Number of birds	992
Pullets	645
Hens	356
Per cent of pullets in total number of birds	64.5
Farm income	$2,697.00
Size of farm (acres)	17.8
Labor income per bird	$2.25

In the evolution of the standardized plan, many facts must be taken into consideration. Some cannot be measured or even approximated. About the most important factor in this group is the capability of the owner, his experience and business ability. In this study this factor is eliminated, or it is supposed that he is experienced, with a good knowledge of the business and a keen business ability. This standard can be only theoretical, since final success

is measured by the man, yet it will enable many a man, either experienced or amateur, to use it as a measure of his accomplishments and as a guidepost by which to set himself right.

To analyze the above figures briefly, we find that a 1000-bird breeding farm should have at least 17 acres (the price has not been included here, as this factor varies so in various locations). Next, it must have invested in buildings, equipment and stock approximately $7000. It will cost to operate this farm over $2500, with the owner's labor not included, from which a gross revenue of over $5000 is realized. This returns a labor income after interest on total investment is deducted of approximately $2,225. This means a labor income per bird of $2.25. Such a farm should have at least one-third of the adult birds of breeding age. These summarized figures are interesting in themselves, and they will be of even more interest when compared with the figures from the egg farms which will appear in bulletin form shortly, and also when compared with similar figures from farm and city flocks, the data for which are being secured and tabulated. The study of 14 typical breeding establishments shows the fact that there are possibilities in this line of work far ahead of straight egg farming. It behooves every poultry keeper to become a breeder, raise better stock, trap-nest in a limited way at least, and sell baby chicks, hatching eggs, cockerels and pullets, for from these sources come the excess profits.

Full plans and details for all forms of equipment and management for a standardized plant are being evolved and will be presented shortly.

4. The Elaboration of Growth and Production Standard for Poultry

Very little of a definite nature has been accomplished along the line of standardization of growth and performance of poultry. The department proposes to evolve through experimentation and bibliographical study a workable standard with which poultrymen of all classes can compare the efficiency of this work. This will include growth standards which will give the required weight of growing chickens in weekly periods from hatching time to maturity, covering as many breeds of poultry as it is possible to secure authentic data for. The second phase of this study will be the elaboration of a production standard which will include the percentage production

which should be expected from a normal flock of laying hens during each month of the year for both pullets and yearlings, and also show the percentage of total production which should be attained each month of the year. This standard will serve as a guide which will enable the beginner in poultry work especially to check up the efficiency and accuracy of his work.

E.—THE FACTORS AFFECTING THE EFFICIENCY OF POULTRY RESEARCH METHODS

1. Error Factor in Experimental Analysis

One of the most important parts of any experiment is the clear, accurate, concise and logical analysis of the results. The accumulation of data, measurements and records is more or less simple, depending, of course, upon the general type and requirements of the particular project at hand. But the analysis of the results accumulated and expressed in tables and figures is the real value that justifies the performance of the work. In too many cases the analysis of research data is apt to be somewhat incomplete, mainly because of a lack of appreciation of all the factors that may have a bearing upon the project. With broader experience and more careful attention to the analysis of data, some of the present deficiencies will be corrected. It would seem that any attempt to increase the percentage of accuracy and correctness in the analysis of research data would be a step nearer the goal of absolute accuracy in measuring results. With this idea in mind, and particularly suggested after attempting to analyze the results of a certain laying hen experiment a year or two ago, an experiment was outlined and carried on during the past year, in which 8 pens of Single Comb White Leghorn pullets were used. Each flock contained an average of 44 females throughout the year, extending from October 1, 1916, through September 30, 1917. Each flock was housed in identically the same kind of pen, 8 pens in the long laying house on the new state poultry farm being available for this purpose. The same feed, care and general management were given to each pen. All 8 flocks were of the same size, and were kept under the same conditions throughout the year, and thus no varying factor was introduced. The only factor that did vary between the different pens then was to be found within the birds themselves, or was a matter of differences in con-

stitution, either physical or gametic, or both. It was assumed that under these conditions, and particularly since in the selection of the individuals used, an attempt was made to have all the birds uniform in so far as external characteristics would indicate, it would be possible to estimate with at least some fair degree of accuracy the normal variations indicated by such flocks. This would be measured principally by the amount of egg production. Any differences between the flocks in the number of eggs produced would not be due to any differences in feeding or management, as these were constant in all cases, but would rather be due to a factor which might be called an individuality factor, or an error factor. This factor would apply only to feeding and managerial experiments, but this would be a start in the completion of a series of error factors that might be worked out to apply to various types of experiments.

Table 13 shows the egg production for the year in the eight pens. There are several points that should be considered in looking over this table. First, the pullets used were March-hatched, half-way between February and April-hatched chicks, resulting in the production starting at a fair percentage during October, but dropping early in November and not picking up again until later in the winter. The March-hatched pullets went into a moult at a time when it proved to be rather prolonged, not of short duration, as was the case with February-hatched birds. The February-hatched pullets in other pens laid well during late August and September, but the March-hatched birds laid only a short time before moulting. The April hatched birds did not moult in the first winter. Second, the low total production in some pens was due not only to this moulting, but in part also to the low production during this last summer, when a slight disease epidemic went through the flock, affecting all in about the same way, not causing a heavy mortality, but decreasing egg production to a low percentage. In spite of these apparent setbacks to the most successful completion of the experiment, the results have not been noticeably altered, as the conditions above referred to were practically constant in all flocks.

Table 14 indicates the average mean, or average production in number of eggs per pen per month throughout the year; the differences between the production of the separate pens and the average mean for each month; the total plus and minus variations from the average mean, and the average plus and minus variations; the plus

Table 14

Plus and Minus Variations from Average Mean in Error Factor Experiment

MONTH 1916	Pen 25	Pen 26	Pen 27	Pen 28	Pen 29	Pen 30	Pen 31	Pen 32	Total +	Total —	Ave. +	Ave. —
ctober	+ 12.4	+ 63.4	— 2.6	+ 68.4	+ 55.4	— 50.6	— 36.6	—109.6	—199.6	—199.4	49.9	49.9
ovember	— 62.0	+ 28.0	+ 26.0	+ 15.0	— 59.0	— 52.0	— 11.0	+115.0	—184.0	—184.0	46.0	46.0
ecember	— 13.4	— 68.4	+ 46.6	— 36.4	— 5.4	— 8.4	— 3.4	+ 88.6	—135.2	—135.4	67.6	22.5
1917												
anuary	— 37.4	—106.4	— 7.4	+ 50.6	+ 26.6	+ 35.6	— 6.4	+ 45.6	167.4	157.6	39.3	39.4
ebruary	— 33.4	— 58.4	+ 85.6	+ 25.6	+ 92.6	— 22.4	— 56.4	— 38.4	203.8	204.0	67.9	40.8
arch	+ 80.6	+ 62.6	+ 99.6	+ 5.6	— 62.4	— 24.4	— 40.4	—121.4	248.4	248.6	62.1	62.1
pril	+115.3	+193.3	+109.3	—114.7	—111.7	— 85.7	— 61.7	— 43.7	417.9	417.5	139.3	83.5
ay	+ 96.0	+164.0	+ 35.0	— 67.0	— 92.0	— 39.0	— 61.0	— 36.0	296.0	295.0	98.3	59.0
une	+ 95.0	+ 22.0	— 80.0	— 56.0	+ 13.0	— 31.0	+ 6.0	+ 31.0	167.0	167.0	33.4	55.6
uly	— 10.0	+ 63.0	+ 18.0	— 25.0	— 27.0	— 76.0	+ 30.0	+ 27.0	138.0	138.0	34.5	34.5
ugust	+ 26.9	+ 9.9	+ 95.9	—119.1	— 15.1	+ 6.9	+ 31.9	— 37.1	171.5	171.3	34.3	57.1
eptember	+ 37.2	+ 13.2	+119.2	— 79.8	— 45.8	— 53.8	— 2.8	+ 13.2	182.8	182.2	45.7	45.5
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
verage means of all pens, by months	281.6	248.0	141.4	223.4	304.4	808.4	642.7	601.0	592.0	388.0	298.1	127.8
lus error, or correction, factor by months	17.72	18.55	47.81	17.14	22.30	7.68	21.69	16.36	5.64	8.89	1.15	3.57
inus error, or correction, factor by months	17.72	18.56	15.91	17.19	13.40	7.68	12.99	9.81	9.39	8.89	1.91	3.55

lus and Minus Factors, Using the Total Yearly Pen Productions Found in table 13 is + 9.05 and — 5.44 per cent.

and minus correction, or error factors for each month; and finally the plus and minus correction, or error factor, based upon the yearly totals.

The first step in figuring the error factor, or correction factor as it may perhaps more properly be called, was to compute the average production per month of the 8 pens in the experiment. The next step was to find the difference, either above or below the mean in the case of each pen for each month. As an example, let us take the average mean (computed from table 13) for the month of October, 1916, which is 281.6. Then we find that pen 25 produced 294 eggs, or 12.4 more eggs than the average for all 8 pens during that month. Then, again, in December, pen 27 produced 2.6 less than the average mean. These two variations are indicated as + 12.4 and — 2.6, respectively. The "+" variations are above the average mean, and the "—" variations below the average mean. The third step was to add the plus and minus variations for each month, and then compute the average plus and minus variations for each month, all of which is indicated in table 14. The fourth step was the division of the plus and minus average variations for each month by the average mean for that month, in order to determine the plus or minus percentage of variation from the average mean. This

Table 13

Total Egg Production in Pens 25 to 32, Inclusive, in the Error Factor Experiment

MONTH	Pen 25	Pen 26	Pen 27	Pen 28	Pen 29	Pen 30	Pen 31	Pen 32
1916								
October	294	345	279	350	337	231	245	172
November	186	276	274	263	189	196	237	363
December	128	73	188	105	136	133	138	230
1917								
January	186	117	216	274	249	259	217	269
February	271	251	390	330	397	282	248	266
March	889	871	908	814	746	784	768	687
April	758	836	752	528	531	557	581	599
May	697	765	636	534	509	562	540	565
June	687	614	512	536	605	561	598	623
July	378	451	406	363	361	312	418	415
August	325	308	394	179	283	305	330	261
September	165	141	247	48	62	74	125	141
Total for year	4964	5048	5202	4324	4425	4256	4445	4591

also is fully indicated in table 14. These figures produced a series of plus and minus variation percentages, one of each for each month. The last step was the computing of plus and minus correction percentage factors by using the total pen productions for the year. These are indicated at the bottom of table 14 as a plus factor of 9.05 and a minus factor of 5.44.

The following conclusions have been drawn as a result of this work:

1. Normal flocks of birds, even though of equal number and uniform in so far as external characteristics are concerned, do vary in amount of egg production from month to month and for the total yearly period, even though fed and managed in identically the same way and manner.

2. It is manifestly unfair in conducting a feeding experiment to suppose that all differences in egg production are due to the varying feeding factors introduced. The same applies in other managerial experiments in which flocks of uniform size and external characteristics are concerned.

3. The inherent capacity of the individual birds in the flocks to produce eggs is a factor that should be reckoned with, and furnishes a basis for the figuring of a definite correction factor.

4. The method of using the above factors is as follows:

(1) At the close of each month the total egg production of flocks under comparison should be discounted by the amount of production equal to the plus or minus percentages of correction, plus in case the production is greater than the average mean, and minus if the pen production is less than the average mean. The same should be done at the close of the year.

(2) As an example to illustrate this method of computation let us suppose that in an experiment testing the relative efficiency of certain forms of grain by-products there were 6 pens, with an average production per pen of 1000 eggs. Pen 1 perhaps laid only 850 eggs, while another pen, No. 4, for instance, laid 1,200 eggs. Is it fair to say that the feed given No. 1 was responsible for the drop of 150 eggs, or that the increase in the other pen was due to the feed it received? Applying the correction factor, then, we would subtract 9.05 per cent from the increase in pen 4 as being the probable variation

due to the inherent capacity to produce eggs. The increase above the 9.05 per cent can then be credited to the feed given. In the other case, where a lesser production than the average mean occurred, the loss would be discounted 5.44 per cent, as a correction for other than the feeding factor.

(3) This means that the feeding, or other managerial factors that may be tested, will not have to answer for a variation that is probably due to differences in powers of fecundity and not responsible to the factors under test. It will tend to make the analysis of such experiments more nearly correct.

(4) If a larger number of pens were available from which to get records to calculate this correction factor, it could be computed with greater accuracy, as the larger the mass of data used the more nearly correct the final result should be, since the law of averages would be more nearly fulfilled. But, in this case several hundred birds were used and 8 pens, sufficient to arrive at an approximately correct figure. Further experimentation may change the numerical value of this figure, but the one given is believed to be nearly correct, for average conditions.

In addition to the work outlined briefly above, the department planned and carried on another project which was along similar lines. It dealt more specifically with the effect of individual hens' records upon the total flock production. This work was carried out largely by Mr. William Whynman.

Recent years of experimentation have given us the now nearly universally accepted fact that there is in every individual hen an inherited capability or power to produce a certain number of eggs. This inherent capacity is a part of the so-called gametic constitution of the bird. It is said that this characteristic in normal individuals is high or low, meaning that certain birds have inherited a tendency to produce a fairly large number of eggs, while others have received a more or less contrary ability. Each individual fowl may be constituted differently with regard to this character. If this assumption is true, and undoubtedly the majority of poultry investigators accept it, then there is a very distinct individuality factor that must be ever borne in mind in the planning of any and all experimental or research projects in the field of poultry husbandry, particularly in so far as the results of such projects are to be measured at least

in part by the amount of egg production. In experiments that have to do with methods and kinds of feeding, or which are primarily for the object of ascertaining the effect of varying environments on laying hens, the factor here referred to has a very significant place. It was in the analysis of the data which accumulated during the progress of a feeding experiment in which 8 pens were included, and in these 240 individual fowls, that the fundamental and essential importance of considering the individual performances of every fowl was first pointed out at the New Jersey Station. Flock totals and averages mean little unless analyzed in light of this individuality factor. Just what relationship may exist between the individual performances and the flock averages we hope to find out through a thorough study of data already accumulated, and from more or less extensive research projects that are under way or planned for the coming year.

In the fall of 1915 eight pens, similarly built and furnished, were filled with pullets, thirty in each pen. Four flocks were of the Barred Plymouth Rock breed, and four were composed of Single Comb White Leghorns. In a word, it was intended to try the following feeding experiment: *one pen of each breed to receive a ration* in which 20 per cent of Eg-O-Milk Albumen was put in the mash instead of meat scrap, the second series to receive a dry mash containing 10 per cent each of Eg-O-Milk Albumen and meat scrap, the third to receive a dry mash containing 20 per cent of milk powder, and the last two pens to be given the regulation New Jersey rations for laying hens. As all conditions of housing and management were identical for all pens, it was assumed that the varying factor would be the source and kind of protein supplied in the dry mashes.

It is thought that the system of obtaining birds, with which to conduct this feeding test, was not far different from that which has been used in many similar experiments. Two large flocks of pullets of the same age, one of each breed, were at hand from which to choose the birds for these flocks. All the available pullets were carefully handled and one bird was placed in each pen in succession until the full number of thirty was obtained. In this way the greatest possible uniformity as far as external appearances indicated was attained. It is perfectly plain that the individuals that were used to make up these test flocks were not and could not be selected on any other basis than that of uniformity in age, development, apparent

vitality and strength, and evenness of appearance. They were, in each breed, all chicks of the same strain, but the individual parentage of the pullets was not known. It is here that the individuality factor was omitted. But this has been the case in many feeding experiments. Some have estimated that any variation or error that was due to difference in inherited powers of egg production would tend to balance itself between pens, but this question can be raised for further consideration and proof.

Upon the completion of a 10 months' period, during which all the birds in each flock had been carefully trap-nested, the flocks were broken up, because of local conditions. At that time the results of the experiment in feeding were tabulated, and later analyzed.

The total flock production for the two flocks that received the 20 per cent Eg-O-Milk Albumen mash was 3,263 eggs for the Leghorns and 3,416 eggs for the Barred Plymouth Rocks. In the next series, receiving both meat scrap and Eg-O-Milk Albumen, the total production was 3,904 and 3,948 eggs, respectively. In the third series, getting a commercial milk powder mash, 3,547 and 4,178 eggs were produced, and in the check pens the totals were 3,292 and 3,823, respectively. Viewing these figures from the standpoint of a feeding experiment, it must be admitted that they are rather disappointing, for the two breeds fail to check each other with any degree of closeness. The differences between the production of the flocks of the same breed were not so large as to warrant accepting them as being due to the variations in the rations. Consequently, the first step appeared to be in the direction of looking back of the flock totals to the production of the individuals. The question naturally arose as to just how much those differences between flock totals were affected by the presence of birds that had made exceptional trap-nest records, or by those that had been drones throughout the greater part of the period. The results of inquiring into this matter proved to be very interesting. That individuality did figure was at once apparent.

In order to have some basis of grouping the birds which possessed similar egg-laying powers, all the 240 individuals were divided into six classes.

Birds producing from 1 to 49 eggs in 10 months were placed in Class 1.

Birds producing from 50 to 99 eggs in 10 months were placed in Class 2.

Birds producing from 100 to 124 eggs in 10 months were placed in Class 3.

Birds producing from 125 to 149 eggs in 10 months were placed in Class 4.

Birds producing from 150 to 174 eggs in 10 months were placed in Class 5.

Birds producing from 175 to 200 eggs and above in 10 months were placed in Class 6.

In each flock the individuals were grouped according to this method, with the result that rather startling results were noted. The production tables for Pen F and H give a fair example of how truly the individuality factor did enter into explaining the difference of 612 eggs. Pen F happened to have among its numbers a goodly proportion of hens that undoubtedly did inherit high fecundity from their parent stock, while, on the other hand, Pen H did not contain any exceptional producers, but rather several hens of very low fecundity. The figures for Pen F are 2 birds in Class 6, 3 in Class 5, 4 in Class 4, 8 in Class 3, and 10 in Class 2, with only 3 in Class 1. In the other pen no individuals were included in Classes 5 or 6, but 2 in Class 4, 6 in Class 3, with 17 in Class 2, and 5 in Class 1. The higher total egg production in Pen F can therefore be accounted for by the presence of more hens of high fecundity and less of low fecundity. These two pens were fed differently, but it is manifestly unfair to say that the increased total production of Pen F was due to the addition of commercial third-grade milk powder to the regulation ration which Pen H received. These two pens are not unlike the others. In each case the correlation between individuality and flock averages was pronounced, as is evidenced in table 15.

The line was drawn between Classes 1 and 2 because as a matter of fact the birds which were in Class 3 or above were saved, while those below were sold. The line perhaps should have been drawn between Classes 3 and 4, as this would have meant the selection of only the really good hens, birds such as should have been fitted for the breeding pens of another season. If this had been done the correlation would have been even more pronounced and distinct.

In order to make this point a little clearer, let us suppose that in the selection of birds for these two pens, F and H, individuals Nos. 54 and 59 had been placed in Pen H instead of in Pen F, and that Nos. 119 and 120 had been put in Pen F in their places. Such

a thing might easily have happened, as it was only chance that placed them as they were actually found, the two high-fecundity birds in the same pen and the two low-fecundity birds together in the other pen. The totals for these two pens would have been very different, showing, then, a difference of only 120 eggs, instead of 612. There are nearly 500 eggs that could be accounted for by the chance that one pen drew two exceptionally high producers, while the other drew two exceptionally low producers. This is not the only instance found in the analysis of the data that pointed to the same fact; for there were many others. Over and over again the controlling importance of the individual performance records asserted itself.

Table 15

Figures Showing Correction Between Individuality and Flock Averages

Plymouth Rocks	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
F (3904)	3	9	9	4	3	2
		(27)			(33)	
G (3547)	2	13	11	3	1	0
H (3292)	5	17	6	2	0	0
		(40)			(20)	
E (3264)	5	13	11	0	1	0
White Leghorns						
C (4178)	3	7	4	6	9	1
		(22)			(38)	
B (3948)	3	9	4	7	7	0
D (3825)	5	5	12	6	2	0
		(30)			(31)	
A (3416)	2	18	7	4	0	0

The evidence which assimilation of these figures and facts presented would seem to warrant considering this factor of individuality a rather important problem. Undoubtedly, there are ways and means by which to take into account the error which it introduces into an experimental project. Just which method will prove most fair and satisfactory must be determined by future experience. There are a few suggestions that came as a result of observations in connection with this project.

Perhaps the most logical possibility to mention first is that of determining a mathematical factor which can be used in correcting the error in figures which express the results of flock experiments

of a nature similar to that mentioned. In view of present study, it would seem fair to base such a mathematical factor upon an average production, and upon a normal variation in either direction from that average mean. In other words, such an error factor would be expressed as a certain amount to be added to or subtracted from the production in a flock that is under some sort of experiment, this to be done in each flock in the particular test under observation to correct for the effect of differences in inherited powers of fecundity. Such a project has been discussed in above paragraphs. This method of getting around the individuality factor, if it proves fair and feasible, ought to be of value in many instances, where possibly the following suggestions, primarily because of local conditions, would be impracticable.

As has been suggested earlier in this report the principal fault in planning feeding experiments has been the neglect of considering the pedigree of the individual fowls with regard to egg production. In some experimental work, at several stations, an effort has been made to eliminate this error by using sisters in the various experimental pens. For instance, if a feeding project were outlined, requiring 5 pens, the needs of this experiment would be anticipated the year before, and trap-nesting and pedigree work would be carried on to such an extent as would furnish at least 5 own sisters from every mating. Then one sister would be placed in each flock, or there would be at least one member of the same family in each flock. There seem to be some objections to this, although it is undoubtedly a step in the right direction. Do the female progeny of a single mating inherit similar powers of fecundity? If they do, this objection is withdrawn. Then again, such a method of selection of birds for a feeding or any other kind of management experiment would limit the experiment to a small number of flocks, with a small membership each, or else a tremendous amount of pedigree hatching would be required in the previous spring. To get any number of such related pullets must require the hatching and rearing of a very large number of chicks, many more than would be possible on the average experimental farm. To cut down the number of birds in a flock to a matter of a few individuals tends to lessen the value of the results, for numbers count in work of this kind, and excessive proof is not objectionable in any case.

Closely related to this suggestion is one that would require the use of daughters of the same sire in the various pens. This is

accepting the theory that fecundity is transmitted through the male line. Probably more accurate results would accrue and less errors if such a method were placed in operation. Both of these plans provide for the use of pullets in experimental work such as has been referred to.

Is it absolutely necessary to use pullets for work of this nature? This question leads to another possible solution of the problem. Out of the flocks which have already been mentioned it was possible to select a large number of individuals that, by their pullet year's production, had proved themselves to be of practically the same gametic constitution with regard to the character of fecundity. These birds were in splendid condition, and their trap-nest record for the following year indicated that their production was good through a second year. Would it have been feasible to have constituted a series of flocks for a feeding experiment from these birds? This is a fourth suggestion, then, that yearling birds might be used instead of pullets in future experimentation. This would require the trap-nesting of a considerable number of pullets, which, however, could all be managed in large flocks, without a serious outlay for additional labor. This would furnish valuable statistics upon the question of individual habits of layers as well as furnishing data upon which to base the selection of experimental yearlings. In the usual feeding experiment it is the comparative production of flocks, rather than the total production, that indicates the relative efficiency of feeds or methods used.

It is entirely possible that this procedure may be open to criticism, especially upon the grounds that in some instances the first year's egg production does not indicate truly what type of egg producer the bird may be. In bulletin 148 of the Utah Agricultural Experiment Station, Ball, Alder and Egbert (page 43) point out that "the ten hens in the different flocks that laid the most the first year made the highest three-year averages and were, therefore, the highest producers for that length of time, and further the three-year averages decreased in the same relative order as the first year production, with only one or two exceptions, down to the lowest ten in each flock, so that, to that extent at least, the first-year production is an accurate indication of the total three-year production." There may be some error introduced by selecting yearlings with practically the same first-year averages, but is it as great as the other error? Experiments now running at the New Jersey Station will point this

out during the coming year. We can yet learn much about the production habits of the domestic fowl.

There are probably many other ways or means of meeting this question, but at present these possibilities have held our attention. It certainly seems that we must acknowledge the inherent capacity of every fowl to produce eggs in whatever line of research we attempt. That the mode of inheritance of the character of fecundity is still somewhat debated makes the method of procedure a bit uncertain, but this will clear up as more conclusive proof is furnished by poultry breeders. That the individuals in every poultry flock may receive widely varying powers of egg production from the parent stock offers further obstacle to the easy and quick solution of the accurate and proper analysis of research results.

F.—MINOR PROJECTS

FACTORS AFFECTING PREPARATION, MARKETING AND DISPOSITION OF POULTRY PRODUCTS

1. Home Preservation of Eggs

During the past year unusual demands have been made on the department because of the war and the conditions brought about by it. In order to be of the greatest service possible the general trend of some experimental work has been directed toward problems connected with food conservation. One of these projects has had to do with the methods of preserving eggs for home use and consumption. For some time there have been many inquiries regarding the most efficient way in which eggs could be preserved by the housewife during the season of plentiful egg production and comparatively low prices. This season occurs during the spring when the birds come into the period of natural production. Many hundreds of dozens of fresh, sterile eggs were sold by the department, as well as by other poultry farms throughout the state, during this past spring to fill the demand for eggs for preservation purposes. As a result many families will be able to have eggs during the coming winter at a reasonable cost. During normal times, as well as during the very abnormal war times, this practice among housewives should be maintained, as it is undoubtedly a great step toward efficiency in arranging the human diet.

An observation experiment along this line was planned and started during the early part of the past year. Several different suggested forms of egg preservatives were obtained and used. It is believed that the list included examples of the best-known types now offered on the market, or which can be made at home. The following is a list of the various preservatives included in the test:

A. Sodium silicate, or water glass.
B. Lime solution.
C. Fleming's Egg Preserver.
D. Vaseline, or petroleum jelly (melting point 115° F).
E. Yankee Egg Preserver.
F. E-Z Egg Preserver.
G. Morning Glory Egg Preserver.
H. New Jersey mixture of paraffin and white vaseline.
I. Lanoline.
J. Nujol.

It will be noticed that there were two preservatives which required the immersion of the eggs in the liquid, viz., A and B. In these cases several dozen eggs were selected in the spring, all strictly fresh and sterile, and were preserved as follows: Clean earthen, clay, or glass jars were used as containers, because of the undesirability of using metalic containers for such purpose. The eggs were carefully packed into each jar, special care being used to discard all cracked and dirty eggs. In the case of water glass the solution was prepared according to directions with boiled water which had been later cooled, and then poured over the eggs, covering the top layer with at least 2 inches of the liquid. This, together with placing a tight cover on the jars, prevented the exposure of the top eggs which would result from the evaporation of the liquid. In the case of the lime solution the eggs were placed in similar jars and a liquid prepared by pouring a gallon of boiling water over a piece of fresh stone lime about the size of a lemon. To this was added 1½ cups of salt, and the solution allowed to cool.

The second type of preservative consisted of a thick oil or fat with which the surface of the egg shells was anointed. This method might be termed a dry method of preservation, because no liquid was used and the eggs thus preserved were packed in dozen cartons or regulation egg crates. In each case only sufficient of the

preservative was used to give the shell a thin but complete coating of oil or fat. By placing a small amount of the material in the palm of the hands and carefully rolling the eggs between the hands the preservative was quickly and efficiently applied. Preparations C, D, E, F, H and I were in the form of a rather stiff fat, while G and J were in the form of thick oil. The same number of eggs were preserved with each kind of preservative, and half of the number were wrapped in tissue paper before placing in cartons or crates, the other half being packed unwrapped. All the preserved eggs, including those placed in the liquids, were stored in a cool room at an even temperature for a period of several months.

At the close of a 5-months' period several eggs were removed from each of the different lots and carefully examined as to the following points:

A. Condition of shell.

B. Evaporation as indicated by size of air cell, determined by candling.

C. Consistency of albumen, color, odor and general appearance.

D. Color of yolk, firmness of membrane, adherence to shell.

E. Possibility of beating albumen to stiff meringue.

F. Taste and general odor of egg.

Interesting and important results were obtained. At the end of the period all the eggs examined were found to be preserved in about the same condition. No marked differences were noted in the efficiency of any of the types tested. A few eggs were found in each case in which the yolks tended to adhere to the walls of the shell, but only a very few. The general concensus of opinion expressed by a half-dozen people who witnessed the testing of the eggs was that the eggs were preserved in a very fair condition. The albumen in all cases was somewhat watery, but this is to be expected in all eggs not strictly fresh, and does not materially change the quality of the albumen, especially for cooking purposes. A stiff meringue was possible with all samples when the albumen was beaten. No bad odors or foreign tastes were noticed in any lot of preserved eggs.

The following conclusions would seem to be justified as a result of this experiment:

1. The first important point to be observed when contemplating the home preservation of eggs is to secure eggs of first quality. Be sure

that every egg is strictly fresh. Sterile eggs are much to be preferred to fertilized eggs, as the former will not start germ development when subjected to a rather high temperature. A cracked egg, especially in the jars where the liquid preservatives are used, will possible spoil the entire lot if not detected early in the period of preservation. Handle the eggs carefully to avoid cracked eggs. Dirty eggs should be washed or discarded before preserving them.

2. When the liquid forms of preservative are used, the jars should be inspected from time to time, and water added if the evaporation has lowered the surface of the liquid to the top row of eggs.

3. When the fat or oil types of preservatives are used, evaporation is prevented by the anointment of the surfaces of the shells with these materials, which do not evaporate and which close the pores of the shells, thus preventing the evaporation of the inner contents of the eggs.

4. In most cases there seemed to be some added advantage in wrapping the eggs preserved by the latter method in tissue paper, probably aiding in preventing the air from affecting the surface of the eggs.

5. In the cases of eggs preserved by the fat or oil type of preservative, the eggs should be turned every month or so, thus aiding in preventing the yolks from adhering to the shells.

6. Eggs preserved at home by any of the above methods, if carefully prepared for preservation, will be of splendid quality to use in preparation of cooked foods during the winter. The writer ate some eggs, which had been preserved for 6 months by the water-glass method, and were served as fried eggs, but he did not detect that they were not strictly fresh until told. Probably the average stored egg will be used for cooking rather than for table purposes, as fresh eggs are preferred when they can be obtained for use on the table, but preserved eggs may be substituted in many instances.

7. Further tests will be made of the eggs remaining in the various preservatives at the close of 8 and 10-month periods.

It is suggested that housewives who did not preserve any eggs during this past season should plan to do so in the season to come. Not only is it good economy, but it will conserve food in good condition. The work outlined above has indicated that any of the several methods can be used with good success. Follow directions, which are usually simple and easy to understand, and preserve eggs for home use.

2. Price Variation for Poultry Products at New York Markets

Perhaps the most important market for poultry products in this country is our largest city, New York. To the New Jersey poultry producer, the conditions on this market are of supreme importance, as this great city is near at hand, and is the natural market to which the greater percentage of poultry products are sent. Of course, local Jersey markets require a large amount of these poultry products, but when the entire output of the New Jersey poultry farms

is taken into consideration, the bulk of the products will probably be found to have, at least finally, arrived at some of the many markets which are located in New York City. Because of the first-hand interest which the New York market quotations have to New Jersey poultry raisers, a detailed tabulation has been made by the department during the months beginning November 1, 1916, and extending through October 31, 1917, including in this tabulation the consecutive quotations on the following market classes of poultry products:

1. Eggs.
   a. Fresh gathered extras.
   b. Fresh gathered, storage packed firsts.
   c. Fresh gathered, firsts.
   d. Fresh gathered, seconds and lower grades.
   e. Fresh gathered, dirties No. 1.
   f. Fresh gathered, dirties No. 2.
   g. State, Pennsylvania, and nearby western hennery whites, fine to fancy.
   h. State, Pennsylvania, and nearby western hennery whites, ordinary to prime.
   i. Western and southern gathered whites.
   j. State, Pennsylvania, and nearby hennery browns.
   k. State, Pennsylvania, and nearby gathered brown and mixed colors, ungraded.
   l. Duck eggs, nearby Indian Runners.
   m. Duck eggs, Baltimore, prime to choice.
   n. Duck eggs, western and southern prime.
2. Dressed poultry.
   a. Philadelphia and Long Island fancy broilers, dry packed, 3 lbs. to pair.
   b. Eastern broilers 3½ to 4¼ lbs. to pair.
   c. Fowls, fresh, dry packed, milk fed.
   d. Fowls, fresh, iced.
   e. Old cocks, fresh packed, either way.
   f. Long Island ducklings.
3. Live poultry.
   a. Fowls.
   b. Old roosters.
   c. Broilers.
   d. Long Island ducks.

These same classes will be tabulated again during the coming year, and several other classes will also be studied, as refrigerator egg classes, live and dressed chicken and roaster, as well as capon classes.

Tables 15 and 16, respectively, give the monthly and yearly average prices for the market products named.

Of course, these figures do not show the fluctuations in prices during each month. After another year's tabulations, comparative graphs can be plotted, comparing the market prices during the two

Table 15

Variations in Market Egg Prices, New York City

Month	Class 1 cents	Class 2 cents	Class 3 cents	Class 4 cents	Class 5 cents	Class 6 cents
1916						
November	68.00	54.29	46.54	54.41	....	....
December	61.60	53.45	50.80	53.40	....	....
1917						
January	53.77	50.96	48.89	49.05	....	....
February	48.50	46.61	46.35	45.91	....	....
March	35.88	31.58	31.61	33.39	33.17	45.00
April	38.93	36.37	36.12	39.58	35.49	40.00
May	38.12	37.56	37.82	36.96	33.02	42.00
June	38.48	37.65	34.92	37.61	34.85	42.00
July	42.71	41.25	38.56	39.10	36.42	....
August	52.88	47.15	43.15	42.81	....	....
September	57.50	50.00	46.00	47.00	....	....
October	64.81	54.51	46.14	51.40	....	....
Average	50.09	45.11	42.24	44.21	34.59	42.22

Class 1 includes eggs named as State, Pennsylvania and nearby hennery whites.
Class 2 includes eggs named as State, Pennsylvania and nearby hennery browns.
Class 3 includes eggs named as Fresh gathered extras.
Class 4 includes eggs named as Western and Southern gathered whites.
Class 5 includes eggs named as Fresh gathered, storage packed firsts.
Class 6 includes eggs named as Duck eggs, nearby Indian Runners.

Table 16

Variations in Market Poultry Prices, New York City

Month	Broilers	Fowls	L. I. Ducks
1916	cents	cents	cents
November	....	17.76	25.00
December	....	19.38	....
1917			
January	....	15.00	21.37
February	27.00	22.70	....
March	55.00	15.73	31.80
April	51.41	25.45	28.71
May	46.64	23.25	27.06
June	34.77	24.93	23.95
July	30.79	20.83	22.88
August	30.95	24.21	23.18
September	....	27.50	26.27
October	....	23.89	28.81
Average for year	39.22	21.72	25.90

years that will go down in the economic history of the country as very particularly interesting years. They are war years and the country is facing economic problems the like of which have never before been presented, and these times will show undoubtedly a marked effect upon the market quotations.

The tables are self-explanatory, indicating in each case the differences in prices during the fall, winter, spring and summer months. The effect of the natural season of heavy production in the spring of the year is well shown in the egg price table. The high summer prices for 1917 and the steadily increasing fall prices show the effect of the peculiar economic conditions, which have been brought about primarily, probably, by the war, and its consequent demands. As this report is being written, the highest market quotation on the New York markets for nearby hennery whites is eighty cents. The prices of egg and poultry-meat production have increased tremendously during the past few months, but this study of the New York market quotations shows that the selling prices of poultry products also have increased and are steadily advancing. While the study has been somewhat incomplete this year, mainly due to the pressure of other work, with another year's market conditions added such a study of market conditions will prove to be exceedingly interesting and valuable to the poultrymen of the state.

G.—POULTRY DISEASE INVESTIGATIONS

1. Investigations Concerning the Prevalence and Distribution of Poultry Diseases in New Jersey

During the past year the poultry department has examined 140 diseased birds which were sent in from various parts of the state. Of these 140 cases, 58 were diseases of the reproduction system, 5 tuberculosis, 5 canker, 4 roup, 5 congestion of the lungs, 2 pneumonia, 7 indigestion, 2 congestion of the liver, 1 jaundice, 1 visceral gout, 1 catarrh, 2 heat prostration, and the rest miscellaneous, such as flesh tumor, broken legs, and other mechanical injuries.

Under the head of reproductory diseases are included prolapsis of the oviduct, miscarriage and reabsorption of the ova, one ovarian tumor, and one typical case of vent gleet. It is interesting to note that of all diseases reported, those of the reproductory system are the most numerous. Many cases were found where eggs fully formed had broken through the ruptured oviduct, and were lodged

in the abdominal cavity. In one bird as many as 16 fully formed yolks were found. In some birds there was a large amount of fat, due to the reabsorption of the ova. Of these diseases, miscarriage of ova, absorption of ova, ruptured oviducts, and broken eggs are possibly due to forced feeding. Most forcing feeds and laying rations contain some concentrated feeding stuffs. It is natural to suppose that under the strain, caused by continued laying, a bird of weaker vitality than the rest, should break down somewhere. As it is, this system of the bird's body which is under the most strain, and is working constantly, it is natural that it should pay the penalty by breaking down from any one of the above-mentioned troubles. Several birds which had never laid an egg were opened and were found to be suffering from miscarriage and reabsorption of the ova. It is possible, then, that this is one of the causes, in some pedigree laying flocks, of low production of some individuals which have every external appearance of high performance. It is hard for the poultryman to know that these troubles are in his flock, yet by examining carefully birds which he knows are not laying, he may find that any one of these troubles may be the cause of their non-productiveness. In most cases, he can tell by feeling of the bird's abdomen. Birds which are suffering from these troubles, and which have not laid, will be very large and will weigh a great deal more than they should. By careful observation, then, the poultryman can eliminate such birds from his flock for use on the table.

Grouped under the head of diseases of the reproductory system are cases of abdominal dropsy, an aggravated form of peritonitis. In this disease the oviduct has become ruptured, and large quantities of watery liquid have formed. Very often such cases can be cured by making a small opening in the abdomen and enclosed water sack, with a sharp knife, allowing the water to drain off. In such cases, the bird should receive very careful attention for the next few days, to avoid infection from the wound. In most cases the bird will come around all right, as the operation is not a very serious one.

The cases of tuberculosis examined were typical ones. It ought not to be a very difficult proposition for a poultryman to go in to his flock and pick out cases of tuberculosis. The emaciated condition, accompanied by a dull and lazy appearance, should give anyone a clue to the cause. When opened, upon post mortem examination, the liver will usually be found to contain large white spots, the num-

ber and size of *the spots depending upon the* stage of *the disease.* When the emaciated condition referred to above is noticed, the bird should be removed immediately, examined, and the body burned to avoid danger of spreading this contagious disease.

The usual number of roup and canker cases are reported from various sections of the state. These diseases are pretty well known by large poultrymen and people who keep small back yard flocks; so it is not necessary to go into detail with regard to them. The other diseases reported are not so common, and not apt to be found so often. There is no danger of contagion from these, so the precautions against their spread are not nearly so important as with tuberculosis, roup, canker and common colds. All precautions should be observed, however, against any disease, by keeping the houses clean, spraying the interior of the house at least three times a year, changing litter when the old litter becomes dirty, and by using clean drinking utensils and mash hoppers. Keep the poultry house dry and clean, with plenty of sunlight and fresh air, but no drafts, and if the birds are not exceptionally crowded, serious loss from disease will be very uncommon. A normal mortality in every commercial flock of from 5 to 10 per cent is to be expected, due to causes beyond the control of the owner.

IV

THE VINELAND INTERNATIONAL EGG LAYING AND BREEDING CONTEST

The research projects which are being conducted at the Vineland contest have been previously listed. No complete publication dealing with the various problems under investigation will be issued until the work can be checked for the 3-year period of the contest. Minor reports and bulletins of a technical nature will be published during the coming months in the form of circulars and press reports. A complete bulletin dealing with the first year's results of the contest will be issued *during the winter.*

Vineland Contest Winnings

The first year's performance of the birds at the Vineland International Egg Laying and Breeding Contest has proven exceptionally gratifying.

All poultry breeders will be especially interested in a few brief statements covering the more important records, and the exceptional performances which were made in the Vineland International Egg Laying and Breeding Contest during its first year.

Of particular interest and importance is the pen making the highest score. This was pen 88, of Single Comb White Leghorns, bred and owned by J. Percy Van Zandt of Blawenburg, N. J. Mr. Van Zandt's pen took the lead during the first month of the contest, and held it to the finish. This pen laid 2,212 eggs, or an average of 221 eggs per bird, which is a 60.6 per cent production. Truly, a wonderful performance! Eight birds in this pen averaged over 200 eggs each. The highest bird in the pen laid 264 eggs. Mr. Van Zandt's winning was not due so much to one or two especially productive hens, but rather to a well-balanced pen of individuals, all of which produced remarkably well. Mr. Van Zandt is an extensive breeder of White Leghorns, and has been carefully breeding for a number of years for increased production. He is a graduate of the Short Courses of the New Jersey State Agricultural College, and has been applying modern methods in breeding in an effort to obtain the results secured.

The honor of having the second high pen belongs to P. G. Platt, of Wallingford, Pa. This pen, No. 76, composed of Single Comb White Leghorns, produced during the year 2,173 eggs; and, during the last six weeks of the contest, gave Mr. Van Zandt's pen a very close run for the first honors. This second-high pen laid an average production during the year of 59.7 per cent. Two hens in Mr. Platt's pen were characterized by extremely long cycles, each having laid on 46 consecutive days. Mr. Platt is to be congratulated upon the success of his pen, for it is a just reward for many years of faithful and consistent breeding toward increased and more efficient egg production.

The third-high pen honors go to pen 89, owned by Shurtz and Voegtlen, of Lebanon, New Jersey, with a production of 2,115 eggs, or an average of over 211 eggs per bird. This pen has produced consistently from the beginning of the contest, and has given the leaders a close fight for honors. The third pen, as well as Mr. Platt's, is composed of consistent producers; both contained 7 birds, which laid over 200 eggs during the year.

The fourth-high pen was No. 62, Single Comb White Leghorns, owned by Holliston Hill Poultry Farm, Holliston, Mass., with a

production of 2,114 eggs, or only one egg behind third place. This pen is of special interest because it contains hen No. 622, which was the second highest hen in the contest, having laid 290 eggs.

Fifth honors go to No. 43, owned by Will Barron, of Bartle, near Preston, England. This pen produced 2,053 eggs, and showed wonderful persistency of production throughout the contest.

These first five pens, as previously enumerated, are the only ones which laid over 2,000 eggs, and the fact that they are all Single Comb White Leghorns, speaks well for the egg-producing ability of this popular Mediterranean breed. The high pens in the other varieties represented at the contest are as follows:

The Barred Plymouth Rock honor goes to pen No. 1, owned by Garret Buck, of Colt's Neck, N. J., which produced 1,956 eggs. Mr. Buck's pen is characterized by three hens which showed extreme cycles of production. One bird, hen No. 7, made two exceptionally long runs of 34 and 37 eggs, respectively. Mr. Buck's hen, No. 9, has the honor of standing fifth in individual production in the contest, with 278 eggs to her credit, and his hen No. 7 stands sixth, with a production of 272 eggs. Mr. Buck is a large potato farmer in Monmouth County. He devotes considerable time and attention to the breeding of his Plymouth Rocks, which are exceptionally vigorous and healthy, as a result of being raised under free-range farm conditions.

White Plymouth Rock honors go to pen 10, owned by Holliston Hill Poultry Farm, with a production of 1,985 eggs. To this pen should go one of the greatest honors of the entire contest, due to the fact that hen No. 6 laid 301 eggs during the 365 days. This hen is a remarkably fine specimen of the breed, and shows wonderful vitality and vigor. Holliston Hill Poultry Farm should receive special credit for having bred this wonderful pen of White Plymouth Rocks, which stands sixth in the contest, and contains the only hen which laid over 300 eggs. This farm should receive special mention for having bred the fourth-high pen in the contest, of Single Comb White Leghorns, which contained the second highest individual hen in the contest, with a production of 290 eggs.

The high honor in Columbian Plymouth Rocks was won by Mr. J. M. Jones of Hornerstown, N. J., the breeder of the famous hen, "Columbian Queen," which laid 284 eggs in a previous contest. Mr. Jones' pen, No. 17, laid 1,854 eggs, and he is to be especially congratulated on account of the fact that his hen No. 179 succeeded

in laying 288 eggs. This hen, also, has the distinction of being third highest hen in the entire contest.

White Wyandotte honors were won by pen 22, owned by Lusscroft Farm, Sussex, N. J., with a production of 1,761 eggs.

Columbian Wyandotte honors were won by pen 27, with a production of 1,513 eggs. This pen is owned by Lake Farm, Slocum, R. I.

Buff Wyandotte honors were won by pen 30, with a production of 1,591 eggs, owned by Clark and Howland, West Paulet, Vt.

Rhode Island Reds succeeded in making a remarkable showing, the high honors going to pen 39 with a production of 1,966 eggs. This pen is owned by Underhill Brothers of Lakewood, N. J. These young men should be given great credit for the excellent performance made by birds of their own breeding.

Single Comb Buff Leghorns were led by pen 95, which laid 1,448 eggs. This pen was owned by H. G. Richardson, of Etra, N. J. The Single Comb Black Leghorn honors go to pen 99, with a production of 1,758 eggs, owned by Fred C. Nixon, Quakertown, N. J.

Breed Averages

Of special interest to the various followers of the different breeds of poultry will be the relative production made by the different varieties. The Single Comb Black Leghorns claim the highest honors with an average production per bird of 175 eggs. Mr. Nixon, the owner of pen 99, thereby receives the grand sweepstakes breed prize of $150 for the pen making the highest production in the breed having the highest average. The Single Comb White Leghorns come next with an average production per bird of 171.5 eggs, with the highest honors going to Van Zant's pen, No. 88, winning the second grand breed prize of $100, awarded to the pen making the highest production in the breed having the second highest average. Barred Plymouth Rocks claim third distinction by having averaged 157.9 eggs per bird. Mr. Buck's pen, No. 1, winning the third grand breed prize for the pen making the greatest production in the breed having the third highest average.

Next in order of performance come the Columbian Plymouth Rocks with an average of 153.4 eggs, followed in turn by the White Plymouth Rocks with a production of 151.8 eggs, while White Wyandottes give them a close run with 151.3 eggs. Rhode Island Reds also won the distinction of being close to the other popular American breeds by making an average production of 150.5 eggs per

bird. The Columbian Wyandottes follow with an average production of 141.6 eggs, with Single Comb Buff Leghorns averaging 133.0 eggs per bird, and the Buff Wyandottes 125.6 eggs per bird.

Summary of the Entire Contest

The first year of the Vineland International Egg Laying and Breeding contest closed on October 31, with a production of 161,875 eggs, or an average production for the year of 161.9 eggs per bird, which is a production of 44.4 per cent. The black and white Leghorns were the only varieties to exceed the average production of the contest. The Black Leghorns made 48 per cent and the White Leghorns 46.9 per cent for the year.

What is of still greater interest is the fact that the Leghorn breed has the distinction of leading in per cent of production during nine months of the year, namely: November, January, February, March, April, May, June, July and August. This distinction in December went to the White Wyandottes with the black and white Leghorns following in second and third places, respectively. In September the Plymouth Rocks and in October the Columbian Wyandottes led in per cent production.

The Vineland International Egg Laying and Breeding Contest is operated along entirely different lines, and with broader objects in view from those of any previous contest. The yearling hens which have just completed their first year's performance will be kept right on at the contest during their second year, and trap-nested the same as during the pullet year. A weekly and monthly report of the performance of these 2-year-old birds will be issued in the same way as for the pullet production. Males will be mated with each pen during the coming spring, and eggs will be hatched and the progeny carefully reared during the coming summer. On November 1 next, 10 daughters from each of the 100 pens will replace their parents, and will be trap-nested and tested during their pullet year, which will complete the third year of the contest.

The contest is located at Vineland, N. J., in the center of one of the most intensive egg-producing communities in the world, and under ideal climatic and soil conditions. The contest is open to visitors at all times, and a visit offers poultrymen not only an opportunity to study the contest methods, but to visit the poultrymen in the Vineland district as well. The coming spring months will be an

especially appropriate time to study the contest, for in addition to the 100 laying pens containing the yearling hens, there will be in the neighborhood of 8,000 head of young stock being reared on the contest grounds. All records of the contest are available at a nominal subscription price. For all information and details, address Prof. H. R. Lewis, Supervisor, New Brunswick, N. J.

A complete report of the first year's work will soon be published as a regular bulletin of the Experiment Station. Numerous technical papers and reports will be published from time to time in technical journals and the poultry press. For details, rules and plan of contest, see the annual report of this department for 1916.* The following are the prizes offered, and winnings during the first year:

Prize	Egg Production	Winner	Amount
Monthly pen and individual premiums—			
November high pen	175	Pen 88, J. P. Van Zandt	$5.00
high hen	28	Hen 17, G. W. Buck	5.00
December high pen	210	Pen 88, J. P. Van Zandt	5.00
high hen	29	Hen 15, G. W. Buck	5.00
January high pen	198	Pen 26, H. S. Tuthill	5.00
high hen	29	Hen 15, G. W. Buck	5.00
February high pen	197	Pen 27, Lake Farm	5.00
high hen	27	Hen 331, Belle Ellen Stock Farm	5.00
March high pen	266	Pen 1, G. W. Buck	5.00
high hen	30	Hens 15, 17, 18, G. W. Buck	5.00
April high pen	251	Pen 1, G. W. Buck	5.00
high hen	29	Hen 39, O. C. Luhrs	1.00
		Hen 106, Holliston Hill Farm	1.00
		Hen 108, Holliston Hill Farm	1.00
		Hen 137, Overlook Farm	1.00
		Hen 179, J. M. Jones	1.00
May high pen	259	Pen 93, Willanna Farm	5.00
high hen	30	Hen 106, Holliston Hill Farm	2.50
		Hen 769, P. G. Platt	2.50
June high pen	258	Pen 76, P. G. Platt	5.00
high hen	30	Hen 243, Oakland Farm	1.25
		Hen 763, P. G. Platt	1.25
		Hen 768, P. G. Platt	1.25
		Hen 902, Gustave Walters	1.25
July high pen	245	Pen 76, P. G. Platt	5.00
high hen	29	Hen 763, P. G. Platt	5.00
August high pen	210	Pen 76, P. G. Platt	5.00
high hen	27	Hen 930, W. K. Wixson	5.00
September high pen	170	Pen 8, Woodside Farm	5.00
high hen	25	Hen 83, Woodside Farm	5.00
October high pen	148	Pen 39, Underhill Bros	5.00
high hen	27	Hen 23, Thomas Henry	2.50
		Hen 83, Woodside Farm	2.50

*Report of the poultry department, N. J. Agr. Exp. Sta. 37th Ann. Rpt. (1916), p. 177-187.

Prize	Egg Production	Winner	Amount
Annual Variety Sweepstakes—			
First	1,758	Pen 99, F. C. Nixon	$150.00
Second	2,212	Pen 88, J. P. Van Zandt	100.00
Third	1,956	Pen 1, G. W. Buck	50.00
Exhibition Sweepstakes—			
First	90.3 per cent	Pen 85, Tenacre P. Farm	25.00
Second	89.48 per cent	Pen 89, Shurts & Voegtlen	15.00
Third	89.1 per cent	Pen 61, Hillview Farm	10.00
Individual Yearly Prizes—			
First	301	Hen 106, Holliston Hill Farm	5.00
Second	290	Hen 622, Holliston Hill Farm	5.00
Third	288	Hen 179, J. M. Jones	5.00
Fourth	285	Hen 902, Gustave Walters	5.00
Fifth	285	Hen 19, G. W. Buck	5.00
Sixth	278	Hen 17, G. W. Buck	5.00
State Poultry Association Premiums			
Highest Production regardless of variety	2,212	Pen 88, J. P. Van Zandt	50.00
Greatest Profit over feed cost—			
First	$68.95	Pen 88, J. P. Van Zandt	10.00
Second	$67.37	Pen 76, P. G. Platt	5.00
Greatest economy in production—			
First	1-2.9256	Pen 88, J. P. Van Zandt	10.00
Second	1-3.0421	Pen 89, Shurtz & Voegtlen	5.00
Longest continuous production	53 days	Hen 743, Oakland Farm	10.00
Special Premiums			
Greatest weight of eggs,	289 lbs., 1 oz. (289.09 lbs.)	Pen 62, Holliston Hill Farm	Silver trophy
Highest monthly production—			
November high pen	175	Pen 88, J. P. Van Zandt	Norwich automatic feeder.
December high pen	215	Pen 88, J. P. Van Zandt	Norwich automatic feeder.
January high pen	198	Pen 26, H. S. Tuthill	Norwich automatic feeder.
February high pen	197	Pen 27, Lake Farm	Norwich automatic feeder.
March high pen	266	Pen 1, G. W. Buck	Norwich automatic feeder.
April high pen	251	Pen 1, G. W. Buck	Norwich automatic feeder.
May high pen	259	Pen 93, Willana Farm	Norwich automatic feeder.
June high pen	258	Pen 76, P. G. Platt	Norwich automatic feeder.
July high pen	245	Pen 76, P. G. Platt	Norwich automatic feeder.
August high pen	210	Pen 76, P. G. Platt	Norwich automatic feeder.
September high pen	170	Pen 8, Woodside Farm	Norwich automatic feeder.
October high pen	148	Pen 39, Underhill Bros.	Norwich automatic feeder.

Prize	Egg Production	Winner	Amount
Highest producing Single Comb White Leghorn pen—			
First	2,212	Pen 88, J. P. Van Zandt	Candee colony Brooder stove.
Second	2,176	Pen 76, P. G. Platt	Prairie state colony brooder stove.
Third	2,115	Pen 89, Shurts & Voegtlen	Watson colony brooder stove.

As a matter of permanent record and for the benefit of those who are especially interested, table 17 is here presented, showing the yearly performance of each hen and the totals for each pen for the year.

It will be observed that one hen, No. 106, a White Plymouth Rock, laid 301 eggs, a truly remarkable performance. One hundred and eighty-three hens, or 18.3 per cent, laid 200 eggs or more, which shows consistency of performance.

V

EDUCATIONAL ACTIVITIES

As in past years, the members of the poultry department staff have been constantly active in applying the results of poultry investigational work through all possible educational propaganda. The extension specialist is devoting his entire time to disseminating this information through the medium of lectures, demonstrations and extension projects, and he is cooperating with the county agents and with the local poultry associations. A detailed report of his special activities is found in another part of this volume (p. —). The amount of time and effort given to educational work by members of the research staff has been greater than in past years, due to the need for such work, as it has been the means of stimulating the amount and efficiency of poultry products produced. Hundreds of visits have been made to poultry producers upon request for definite information pertaining to disease, housing, breeding, feeding and other allied subjects. As usual, numerous lectures have been given throughout the state at institutes, before county boards of agriculture, before local poultry associations, housewives' leagues and other organizations doing similar work. Many demonstrations have been held throughout the year which have been widely attended and which have created much interest. The majority of these have dealt with the proper culling of adult stock, to weed out the barren hens and

Table 17

Record of Individual Hens in Vineland International Egg Laying and Breeding Contest

Pen	1	2	3	4	5	6	7	8	9	10	Out eggs	Yearly pen total
1	152	172	175	225	167	167	272	200	278	140	8	1956
2	103	178	181	171	209	136	161	70	194	137	10	1548
3	142	123	165	170	188	129	105	117	151	176	8	1474
4	174	170	152	116	186	137	169	152	228	190	17	1689
5	139	79	58	134	93	134	203	140	193	268	3	1443
6	154	39	191	134	97	111	176	76	104	111	6	1199
7	192	161	99	169	117	128	146	127	128	156	36	1459
8	218	172	199	163	232	112	197	225	207	128	14	1867
9	106	136	206	218	191	129	194	216	127	87	25	1635
10	190	248	162	135	220	301	188	138	188	165	50	1985
11	162	150	154	118	128	116	209	145	153	221	17	1573
12	75	99	192	104	9	184	119	66	138	38	14	1038
13	184	134	132	165	191	239	207	63	135	199	13	1662
14	171	115	163	157	97	135	93	69	67	128	19	1214
15	150	158	188	155	139	168	100	112	140	122	15	1447
16	161	120	156	109	163	93	77	159	103	131	30	1302
17	214	182	154	189	116	145	203	190	288	151	22	1854
18	183	231	132	51	186	139	179	226	9	28	91	1445
19	137	137	172	66	199	42	108	221	115	152	63	1412
20	97	186	181	127	139	66	137	136	112	118	24	1322
21	200	184	132	199	122	168	143	91	182	152	35	1598
22	204	249	136	121	171	166	164	159	177	203	11	1761
23	129	133	223	113	186	166	119	151	136	112	17	1485
24	70	102	164	141	158	94	174	173	117	179	38	1410
25	6	186	145	162	138	239	143	144	82	186	29	1460
26	109	145	197	209	164	155	188	163	205	156	29	1721
27	177	159	133	128	175	140	142	100	178	165	16	1513
28	134	116	106	57	105	185	188	161	234	190	16	1483
29	98	111	139	120	104	43	157	81	141	221	38	1253
30	186	164	121	185	160	151	102	193	144	159	26	1591
31	98	72	149	66	109	80	52	171	0	48	52	897
32	113	72	158	86	189	131	158	89	176	96	21	1279
33	196	95	173	131	191	235	1	203	106	173	18	1522
34	146	168	100	197	178	130	146	104	60	149	27	1425
35	152	186	132	143	89	167	101	183	129	123	21	1410

Table 17—(Continued.)

Pen	1	2	3	4	5	6	7	8	9	10	Out eggs	Yearly pen total
36	190	139	113	112	149	163	96	189	136	165	27	1479
37	154	176	173	151	167	70	190	94	115	207	25	1522
38	109	137	167	136	194	140	199	175	229	140	9	1635
39	148	202	243	207	183	150	170	177	216	241	29	1966
40	106	129	120	87	124	117	44	125	90	121	19	1082
41	178	212	265	266	194	181	153	163	125	191	14	1937
42	165	127	152	263	115	252	219	205	234	90	21	1843
43	210	150	193	177	236	252	231	217	134	247	15	2053
44	101	155	202	113	180	89	191	105	185	146	8	1425
45	154	178	143	186	158	120	210	168	227	147	8	1698
46	156	192	205	211	90	107	186	168	161	236	23	1734
47	137	114	164	160	161	189	139	171	215	210	14	1674
48	170	129	178	197	146	172	190	156	152	219	22	1730
49	166	216	173	163	139	141	161	123	196	151	30	1649
50	112	148	159	170	214	194	163	153	224	180	11	1728
51	198	124	141	189	188	160	144	221	163	190	8	1714
52	184	182	161	164	209	159	141	151	137	116	11	1595
53	178	173	170	198	147	178	257	176	147	146	2	1772
54	181	180	201	159	157	197	146	176	192	172	11	1772
55	177	194	179	220	68	203	161	169	213	146	22	1742
56	163	171	127	169	78	80	121	144	117	121	6	1277
57	171	165	119	160	137	213	143	168	179	164	13	1622
58	137	123	136	203	147	134	119	238	190	88	12	1527
59	209	176	136	109	121	193	147	193	146	173	13	1616
60	187	182	110	136	221	162	171	207	232	148	18	1774
61	148	117	251	119	86	158	111	124	150	160	14	1436
62	246	290	189	218	199	158	192	218	178	222	24	2114
63	180	114	172	143	177	141	174	109	108	86	9	1412
64	126	199	161	173	316	196	192	198	132	116	12	1719
65	209	174	218	129	187	168	200	183	186	186	11	1861
66	160	196	202	193	186	198	91	192	259	181	9	1857
67	136	176	204	113	209	145	187	235	164	176	10	1755
68	147	103	191	216	182	174	120	127	176	165	12	1613
69	201	251	107	306	1	189	186	120	172	214	26	1673
70	175	216	223	153	170	172	201	190	202	131	10	1843
71	165	232	143	165	158	215	142	210	199	202	31	1851
72	135	161	201	101	178	193	177	158	139	155	17	1625
73	103	66	141	158	113	162	101	41	104	103	26	1117
74	162	112	160	199	148	131	133	127	225	159	9	1655
75	133	162	116	140	133	144	187	147	174	165	16	1526

Table 17—(Continued.)

Pen	1	2	3	4	5	6	7	8	9	10	Out eggs	Yearly pen total
76	204	188	233	241	249	185	238	174	219	228	14	2173
77	208	171	212	139	157	184	149	229	195	153	18	1851
78	173	28	209	173	145	128	181	188	178	174	37	1614
79	184	129	173	145	200	159	162	183	149	135	21	1620
80	170	120	125	135	161	191	168	126	220	220	30	1666
81	239	149	166	159	142	175	228	265	125	214	22	1884
82	187	194	196	230	199	181	185	134	154	135	7	1802
83	196	114	162	197	191	138	149	159	205	185	21	1716
84	244	208	187	159	181	142	20	91	3	162	21	1353
85	141	114	97	60	184	83	184	206	162	75	7	1312
86	167	203	176	186	114	251	107	168	179	137	24	1702
87	93	167	149	117	165	177	172	143	169	158	37	1915
88	179	264	181	216	247	239	222	223	204	231	6	2212
89	246	184	177	229	178	211	208	228	212	227	5	2116
90	180	285	145	160	221	179	144	211	148	188	22	1883
91	139	142	134	153	150	151	197	69	130	198	26	1489
92	184	217	211	265	139	217	107	177	191	237	14	1959
93	220	204	169	177	235	234	174	143	166	158	37	1916
94	193	159	216	151	218	156	235	226	185	148	11	1898
95	153	215	183	168	50	173	96	16	180	210	4	1448
96	61	3	145	187	86	111	161	75	183	113	12	1137
97	108	182	145	89	177	220	150	115	62	156	3	1407
98	163	156	157	181	184	200	152	174	201	167	11	1746
99	174	233	222	144	240	181	136	79	155	167	27	1758
100	185	186	168	132	147	156	237	120	154	221	28	1754
										Totals	1983	161875

non-producers, and thereby attain efficiency in production. The poultry department staged an extensive educational exhibit at the Madison Square Garden Poultry Show, at the annual show of the New Jersey State Poultry Association at Elizabeth, and at the annual exhibit of the New Jersey State Poultry Association at Trenton. The members of the department have judged utility classes of poultry and eggs at numerous exhibits, and are devoting considerable time to the promotion and exhibition of farm flocks, thereby creating interest among producers in the egg-laying ability of their birds. During the past year the regular "Hints to Poultrymen" have been published each month, and as usual have been of great value in answering correspondence and in maintaining interest in the local poultry associations. The following is a list of the "Hints to Poultrymen," which were published during the past year:

Month	Title	Author
October	Preparing Birds for Exhibition.	R. F. Irvin
November	The Vineland International Egg Laying and Breeding Contest.	H. R. Lewis
December	Value of Post Mortem Examination.	W. C. Thompson
January	Mating and Early Hatching.	V. G. Aubry
February	Our State Department of Poultry Husbandry, Its Organization and Activities.	H. R. Lewis
March	Colony Brooding.	V. G. Aubry
April	Chick Troubles.	W. C. Thompson
May	The Profitable Capon.	V. G. Aubry
June	Proclamation (Rooster Day).	H. R. Lewis
July	The Moulting of Fowls.	R. F. Irvin
August	Finishing Market Poultry.	W. C. Thompson
September	Selection; The Basis of Improving the Poultry Flock.	H. R. Lewis
October	New Jersey Poultry Survey.	A. G. Waller

The following is a list of these publications which will be published during the coming year:

Month	Title	Author
November	The Cost of Egg Production.	H. R. Lewis
December	Winter Rations for Poultry.	W. C. Thompson
January	Vineland Egg Laying and Breeding Contest; Record of the First Year's Performance.	H. R. Lewis
February	Successful Incubation Practices in New Jersey: Embryo Mortality.	R. R. Hannas
March	Home-Grown Feeds for the Poultry Flock.	H. R. Lewis
April	Feeding and Care of the Brooder Chicks.	V. G. Aubry
May	Possibilities of the Suburban Flock.	H. R. Lewis
June	Summer Management of Growing Chicks.	W. C. Thompson
July	Eliminating the Boarder Hens.	V. G. Aubry
August	Possibilities of the Farm Flock.	Instructor
September	Types of Poultry Keeping.	H. R. Lewis

During the past years members of the department have contributed to the press news letter published by the extension division each week. All possible aid has been given to the organized poultry associations in the state in carrying on educational programs, and cooperating in holding various competitions.

The department participated very actively in the annual meeting and exhibit of the New Jersey State Poultry Association in January, when a complete exhibit was staged, a very attractive egg show was held, and an educational exhibit of standard-bred poultry was featured. A very interesting educational program was given, the details of which follow:

Lecture Program

Thursday, January 25, 1917

Board Room, Second Floor, Armory

9.00 A. M. Breeding the Producers, H. V. Smith, West Willington, Conn.

10.00 A. M. Vigor and Health in the Breeding Flock, W. C. Thompson, New Brunswick, N. J.

10.30 A. M. The Federal Government's Contribution to Poultry Breeding (illustrated), H. M. Lamon, Washington, D. C.

11.30 A. M. Round-Table Discussion, Poultry Breeding, H. R. Lewis, Leader.

Afteruoon Session

1.30 P. M. Managing the Commercial Egg Farm, C. N. Warner, Toms River, N. J.

2.30 P. M. Managing the Farmer's Flock, V. G. Aubry, New Brunswick, N. J.

3.15 P. M. Diversified Poultry Production, H. R. Lewis, New Brunswick, N. J.

4.00 P. M. Round Table Discussion, Poultry Management, H. V. Smith, Leader.

Friday, January 26, 1917

Morning Session

Poultry Production

9.00 A. M. Solving the Housing Problem, W. Theo. Wittman, Mt. Gretna, Pa.

9.45 A. M. Economical and Efficiency Poultry Rations, H. V. Cory, Newark, Del.

10.30 A. M. Round Table Discussion, C. N. Warner, Leader.

11.00 A. M. Adjournment to Alfalfa Session.

Afternoon Session

1.30 P. M. The Contribution of the Fancy in the Development of the Poultry Industry, C. D. Cleveland, Eatontown, N. J.

2.15 P. M. Chalk talks, Our Breeds of Poultry, W. H. Card, Man-

3.15 P. M. The Science of Conditioning, N. L. Chapman, Trenton Junction, N. J.
4.00 P. M. Round Table Discussion, C. D. Cleveland, Eatontown, N. J.

VI

CONCLUSION

In conclusion it may be said that the policy for the ensuing year will be to concentrate the activities of the department upon two or three important problems. An effort will be made to increase in amount and efficiency the production of poultry and eggs. This will be accomplished through all possible channels, and will center upon the problem of increasing the suburban flocks more than the practical or commercial flocks, and a more intensive practice of poultry keeping on farms. Much time will be devoted to the study and the progress of the work at Vineland and the preparation for publication of the results.

More attention than ever before will be devoted to the progress of research problems at the Station farm. With the completion of the plant, better organization of the work, and the concentration of all labor upon the care of the birds, much better results are anticipated.

It is with pleasure that the poultry department is able to make this report of progress, and it is trusted that the ensuing year will be equally as successful.

REPORT OF THE DEPARTMENT OF DAIRY HUSBANDRY

Department of Dairy Husbandry

*William M. Regan, A.M., *Dairy Husbandman.*

†Willes B. Combs, A.M., *Assistant Dairy Husbandman.*

*Appointed July 1, 1917, to succeed William J. Carson, resigned.

†Appointed July 1, 1917, to succeed Lloyd S. Riford, resigned.

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Report of the Department of Dairy Husbandry

William M. Regan

INTRODUCTION

The activities of the department of dairy husbandry for the year ending October 31, 1917, may be listed as follows:

1. Experimental
   Data have been gathered on five different experimental projects.

2. Extension
   The department of dairy husbandry, cooperating with the division of extension, has given advice and assistance to the dairymen of the state through meetings, correspondence and personal visits. Five projects have been carried on with 225 cooperators.

3. Advanced Registry
   All advanced registry work in the state has been supervised by this department. An average of 174 cows were tested each month during the year.

4. Glassware and Testers' License Law
   The examination of all applicants for testers' license and the testing for accuracy of all glassware used in the purchase of milk and cream in New Jersey, has been supervised by this department. Fifty-three testers' licenses have been issued and 2,454 pieces of glassware were tested for accuracy.

EXPERIMENTAL

The principal lines of investigation conducted by the department of dairy husbandry during the past year are as follows:

1. The comparative value of dried vs. wet brewers' grains as a feed for dairy cows.

2. The comparative value of Eastern vs. Western alfalfa hay as a feed for dairy cows.

3. Economical rations for dairy heifers during the winter months.
4. Relation of conformation of dairy heifers to future production.

Feeding Experiments

Dried vs. Wet Brewers' Grains

The purpose of this experiment was to determine the comparative feeding value of dried vs. wet brewers' grains. It was found that 1 pound of dried grains was equal in value for milk production to 4 pounds of the wet grains.

Eastern vs. Western Alfalfa Hay

The object of this experiment was to determine if there was a real difference in the feeding value of bleached hay grown in the East under humid conditions and that grown in the West, and if such a difference was found, to determine how much less valuation per ton the Eastern hay should be given.

The results, while not conclusive, indicate that the choice Western hay was about 2 per cent more efficient for milk production.

Rations for Dairy Heifers During the Winter Months

The object of this experiment was to determine the most economical ration, everything considered, for wintering dairy heifers under New Jersey conditions. While further work is necessary, the results thus far would indicate that a ration of alfalfa or mixed hay with silage, and a grain mixture adapted to the kind of hay will bring about very satisfactory results in the way of growth.

The Relation of Conformation of Dairy Heifers to Future Production

Some 25 different skeletal measurements, together with body weights, are being taken monthly on about 200 animals. The measurements are first made at birth and continued up until the end of the first lactation period. This experiment has been in progress for about one year. No definite conclusions can be drawn until the data have been taken for at least two years more.

EXTENSION WORK

The department of dairy husbandry during the past year has cooperated with the division of extension in giving advice and assistance to the dairymen of the state. This has been accomplished through institute meetings, personal visits, correspondence, and cooperative dairy projects. The following is a list of the projects and the work that is being done under each:

1. Dairy Record Associations

The year was begun with 5 active cow testing associations. During the year 3 new ones were formed, making a total of 8 active associations, as follows:

	No. Members	No. Cows	
Bergen and Passaic County Association.			
Beginning of year	21	385	
Close of year	11	270	(Bergen Co.)
Secretary—H. A. Davidson, Ramsey, N. J.			
Mercer County Association (formed May 1, 1917).			
Beginning of year			
Close of year	19	351	
Secretary—W. G. Oldis, Pennington, N. J.			
Buurlington County Association.			
Beginning of year	9	400	
Close of year	9	400	
Secretary—John V. Bishop, Columbus, N. J.			
Cumberland County Association. (Formed February 19, 1917.)			
Close of year	16	210	
Secretary—Walter Shute, Bridgeton, N. J.			
Salem County Association.			
Beginning of year	22	529	
Close of year	20	500	
Secretary—A. B. Waddington, Woodstown, N. J.			
Sussex County Association.			
Beginning of year	18	587	
Close of year	20	560	
Secretary—W. F. Whittemore, Newton, N. J.			

Wallkill Valley Association.		
Beginning of year	11	314
Close of year	20	490
Secretary—J. S. Katzenstein, Hamburg, N. J.		
Middlesex-Somerset County Association (Formed March 1, 1917).		
Beginning of year	18	360
Close of year	22	420
Secretary—Clayton Quick, R. F. D., New Brunswick, N. J.		
Total beginning of year	99	2575
Total close of year	137	3201

2. **Mixing and Feeding a Home-Made Calf Meal**

   Twenty-two cooperators.

3. **Dairy Record and Feeding Demonstrations**

   Six cooperators

4. **Soiling System as a Supplement for Pastures**

   Two cooperators.

5. **Boys' and Girls' Dairy Clubs**

   Ten cooperating clubs.

An educational market milk scoring demonstration has been inaugurated and two circulars on feeding have been published during the past year.

ADVANCED REGISTRY

The amount of advanced registry work done in the state has increased to the point that it has become a considerable burden upon the department of dairy husbandry to supervise it efficiently.

The following shows the number of cows tested in the advanced registry work during the year, by months:

Month	No. Cows
November	167
December	144
January	162
February	184
March	229
April	193
May	163
June	161
July	168
August	164
September	170
October	184
Total	2089

Number of Official Tests Supervised

Seven-day tests	231
Fourteen-day tests	2
Twenty-one-day tests	1
Thirty-day tests	37
Total number of breeders doing official testing	26

Total Number of Breeders Doing Semi-official 2-Day Work

Breed	No. Herds
Guernsey	15
Jersey	8
Ayrshire	4
Brown Swiss	1
Holstein	2
	30

Number of semi-official tests supervised, 1818.

GLASSWARE AND TESTERS' LICENSE LAW

Fifty-four creameries and milk plants in the state are using Babcock glassware that has been tested for accuracy by this department. Fifty-three certificates of efficiency have been issued to testers. Thirty-six of these have been renewals of licenses that were issued last year. The following is a summary of the glassware tested:

Description	Number of pieces tested	Per cent incorrect
Whole-milk bottles	2101	7.9
Cream test bottles	171	7.6
Pipettes	182	4.39
Total	2454	7.6

THE DAIRY HERD AND EQUIPMENT

The dairy herd October 31, 1917, consisted of 74 animals representing the four dairy breeds and the milking Shorthorns. Fifty-one of these are pure-bred animals. The poorer grade cows are being weeded out and replaced by the pure-bred heifers as soon as they freshen.

During the year a number of pure-bred animals were presented to the Station by philanthropic dairy cattle breeders of the state, as follows:

Mr. G. B. Schley, of Far Hills, New Jersey, presented the College with two pure-bred Ayrshire heifers.

Mr. A. A. Cortelyou, of Somerville, N. J., Mr. Charles L. Roberts, of Basking Ridge, N. J., Mrs. Helen L. Massenat, of Belvidere, N. J., and Mr. Bernhard Meyer, of Finderne, N. J., each presented the College with a pure-bred Holstein heifer.

Mr. W. P. Bliss, of Bernardsville, N. J., presented the College with a pure-bred Guernsey heifer.

The contract has been let for the building and equipment of a modern calf and young stock barn. A bull barn and modern milk house are still needed to make the equipment complete.

REPORT OF THE DEPARTMENT OF SEED ANALYSIS

Department of Seed Analysis

JOHN P. HELYAR, M.SC., *Seed Analyst.*

*NEVADA S. EVANS, A.M., *Assistant Seed Analyst.*

†JESSIE G. FISKE, PH. B., *Assistant Seed Analyst.*

*Resigned June 1, 1917.
†Appointed July 1, 1917.

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Report of the Department of Seed Analysis

JOHN P. HELYAR

INTRODUCTION

Since November 1, 1916, the state seed laboratory has been operating under a new law, differing from the original law in that certain requirements are placed upon local dealers with regard to the attachment of labels to stock which they offer for sale. Such labels must bear statements relative to the purity, germination and weed-seed content of the seeds within the container, and it becomes the function of the laboratory to inspect and analyze samples of such labelled seeds to determine the accuracy of the statements given. The new law also retains the provision for free analysis of samples submitted by residents of the state.

The provisions of the law have, undoubtedly, resulted in an increased demand for service by local seedsmen in order that they may have the information required for proper labelling of their seed stock. The same requirements have also increased the contact between the dealers and the seed laboratory in frequent discussion of forms of labels as well as accuracy of label statements. This particular development is believed to be one of the strongest features of the law. The awakening of the dealers' interest in quality as well as the farmers' is to be considered as extremely valuable. The opportunities for work of educational value are frequent and to fail to take advantage of these, while attempting to confine the activities of the department to the rigid enforcement of police measures, would be fatal to the best development of this work. For this reason, and especially, for the present, it occasionally seems the best policy to sacrifice the letter of the law for the spirit of general improvement which seeks to act through the law.

CHANGES IN STAFF

Miss Nevada S. Evans, assistant seed analyst, resigned June 1, 1917.

Miss Jessie G. Fiske, a graduate of the University of Vermont and acting in the capacity of seed analyst in that institution, accepted the appointment to fill the vacancy, and assumed the duties of assistant seed analyst July 1, 1917.

The inspection of dealers' stock has been carried on largely through the inspectors employed in the fertilizer control, whose work in this field naturally takes them to many merchants that sell agricultural seeds. Mr. W. A. Cray and Mr. H. P. Rood have acted in such capacity during the past season. The experience of these men in the inspection of fertilizers has been valuable to the department, and it would seem wise to continue such a satisfactory arrangement if possible. While the employment of special seed inspectors would enable the department to examine a larger proportion of the seed offered for sale in the state, present funds do not permit of their employment for the entire year, nor would it be possible, with the present staff, to analyze all the samples they would collect.

PUBLICATIONS

During the year the state seed analyst has prepared the following for publication:

Bulletin 302, "Results of Seed Inspection, 1915-1916," giving the results of analysis of official samples collected and analyzed from November 1, 1914, to October 31, 1916.

Circular 66, "Regulations and Instructions Relating to the Labelling, Inspection and Analysis of Seeds in New Jersey."

Circular 72, "The Seed Situation."

Circular 86, "Saving Beans and Peas for Food and Seeding Purposes."

EQUIPMENT

In the purchase of additional equipment to meet the necessary demands for service, the seed laboratory becomes one of the best equipped state seed laboratories in the country. A large germination chamber with electric heating unit and thermostat control adds materially to the capacity of the laboratory for this type of work, making the present total capacity 624 samples. A mechanical seed

counter will do much of the work that has been done by hand. This will serve to reduce the error in counting which may otherwise occur and also materially decrease the time requirement per sample. Other small equipment has been added to facilitate the general work of the laboratory, to gain in accuracy and to limit the time requirement.

ANALYTICAL WORK

Unofficial Samples

The number of unofficial samples received for test has greatly increased and the proportion of increase is much greater than in previous years. Also, it is to be noted that there has been a marked increase in the number of samples of vegetable seeds received. The requirements of the new seed law, undoubtedly, are responsible for much of this additional demand for service inasmuch as local seedsmen are sending a large number of samples. Limits are placed on the number of samples to be tested for any one person or firm so that there can be no danger of monopoly of laboratory service by dealers under the provisions for free tests. Nor is it considered that this service to dealers is a doubtful expenditure. If the seed laboratory can supply the results of reliable tests which will be available to the purchasers of seeds, then it can be considered that this work is a means to the end. It is also evident that many dealers are making purchase on the basis of our laboratory tests, and apparently developing an interest in quality which is stimulated by the legal requirements placed upon vendors.

No general conclusions can be based on the results of analysis of these unofficial samples. Some are very good, some are absolutely worthless. Some are dealers' sale samples, others are apparently from stock that has been carried over one or several years by dealers and farmers. In the main, knowledge of their quality in terms of laboratory tests is desired. Therefore, any statement as to the average or extreme quality of these samples would have little practical value, as it cannot be stated definitely that the seeds were purchased or sold.

Table 1 shows the number of samples of each kind of agricultural seed received and tested for the year.

Table I

Number of Samples Tested—1916-1917

Kind	Unofficial Samples	Official Samples
Grasses and Cereals		
Timothy	52	43
Redtop	21	6
Rhode Island bent grass	5	—
Orchard grass	6	3
Kentucky blue grass	19	4
Canada blue grass	1	—
Fescue species	11	—
Miscellaneous grasses	27	2
Grass mixtures	40	6
Field corn	5	3
Millet	15	17
Rye	4	1
Barley	2	1
Oats	1	—
Leguminous Forage Crops		
Alfalfa	78	25
Alsike clover	52	26
Red clover	76	41
Crimson clover	29	20
White clover	14	4
Sweet clover	5	4
Vetch	12	4
Soybeans	6	3
Field peas	5	1
Cowpeas	21	6
Lupine	2	—
Trefoil	1	—
Miscellaneous Forage Crops		
Buckwheat	1	1
Rape	8	2
Sunflower	1	—
Vegetables		
Asparagus	4	—
Beans	81	3
Beets	60	—
Cabbage	25	1
Carrot	30	2
Celery	16	—
Sweet corn	22	3
Cress	1	—
Cucumber	30	1
Eggplant	3	—
Endive	6	—
Kale	1	—
Kohl rabi	2	—
Leek	3	—
Lettuce	37	1
Mangels	4	8
Muskmelon	13	1
Onion	62	—
Parsley	10	1
Parsnips	4	—
Peas		
Pepper	13	—
Pumpkin	15	—
Radish	29	1
Salsify	1	—
Spinach	19	—
Squash	31	2
Swiss Chard	6	—
Tomato	89	1
Turnip	47	—
Watermelon	14	1
Brussels sprouts	1	—
Gourd	1	—
Okra	1	—
Flowers		
Nasturtium	2	—
Sweat peas	3	—
Total	1165	240

Official Samples

Inspection of stocks of seed offered for sale revealed a condition to be expected at this stage of development of the new seed law, but a condition that will cease to exist in the course of time. Many dealers were apparently entirely ignorant of the existence of the law and, consequently, were offering seeds, as in the past, without any form of label. A few others had attempted to comply with the law, but, misunderstanding the specific requirements, attached labels with insufficient or uncalled for information. Only occasionally were objections raised by dealers against the law, and these were largely based on a distinct misunderstanding of its main features. In such cases, as above mentioned, it becomes the function of the department to make clear the responsibilities of the seedsmen and also to point out the manner in which the law may react to their direct benefit, if they are sincere in their stated efforts to consider the welfare of their patrons and anxious for the development of a trade in this commodity on a sure foundation.

Analyses of 240 official samples secured by inspectors from dealers' labelled stock indicated that the information on the labels was reasonably accurate in most cases. The labels attached to inspected stock were supplied by the wholesale vendor. This will, undoubtedly, develop as the general practice, for the wholesaler relies upon the furnishing of labels as a sole argument and the retail vendor feels that the securing of test information and the attachment of labels involves an effort beyond his interest or business practice. The label must be there, however, and he will, undoubtedly, accept the wholesale vendor's service in supplying it with orders. The question arises, however, as to the responsible party in case the label is found to be inaccurate. It seems to be the sentiment of local merchants that any action for violation should be directed against the wholesaler. On the ground that the law holds the local vendor responsible, and that the supplying of the label by the wholesaler is the result of a business agreement between wholesaler and retailer, the stand is taken that the responsibility of the retailer is not removed. If he suffers loss by prosecution it is a matter for adjustment between himself and the firm supplying illegal labels.

For this year it seems advisable only to resort to publication of

label or with manifestly inaccurate labels. As a matter of public information and especially for the benefit of the retail vendors of the state, it seems advisable to publish the name of the wholesale vendor in connection with each sample. At least one wholesale dealer can be accused of supplying labels with grossly inaccurate information thereon. Whether this is intentional or due to faulty methods in making tests is a matter of question, but publication of the name of the firm in connection with the samples will, no doubt, result in the desired effect. The retail vendor is held to be the responsible party and, accordingly, is not anxious to get into difficulty or have his reputation questioned by purchasing seeds with such faulty labels attached. He should know who is most apt to be reliable in this matter.

WEED-SEED CONTENT OF SAMPLES

In previous reports of this department the results of more or less critical studies of the weed-seed content of samples have been published. Such matter has been presented as would show the kinds of weed seeds identified and the frequency of their occurrence in various kinds of crop seeds. There is little variation in this from year to year, except that new species of infrequent occurrence may be listed, and the frequency of occurrence of the more common weed seeds may increase or decrease. The latter is affected by the source of commercial seed and the conditions of the seed fields from year to year.

During the year 115 kinds of weed seeds have been identified in the unofficial samples tested for purity. The more common of these in the different field-crop seeds are given in the following:

Timothy. Sedge, sheep sorrel, lamb's quarters, pepper grass, cinquefoil, evening primrose, Rugel's plantain, black-eyed Susan.

Redtop. Sedge, slender rush, sheep sorrel, mouse-ear chickweed, cinquefoil, mountain mint, broad-leaved plantain, Rugel's plantain, Yarrow, black-eyed Susan.

Kentucky Blue Grass. Sedge, sheep sorrel, mouse-ear chickweed, shepherd's purse, speedwell.

Red clover. Green foxtail, slender rush, lady's thumb, sheep sorrel, curled dock, lamb's quarters, night-flowering catchfly, cut-leaved cranesbill, self heal, buckhorn, ragweed.

Alsike clover. Sheep sorrel, lamb's quarters, night-flowering catchfly, buttercup, yellow trefoil, dodder, mountain mint, buckhorn, Canada thistle.

Crimson clover. Field foxtail, sheep sorrel, night-flowering catchfly, bird's foot trefoil, cut-leaved cranesbill, blue field madder.

White clover. Sheep sorrel, lamb's quarters, yellow trefoil, buckhorn, broad-leaved plantain.

Alfafa. Green foxtail, lamb's quarters, pigweed, Russian thistle, dodder, buckhorn, ragweed.

IDENTIFICATION OF PLANTS

The work of identifying weed plants submitted to the Experiment Station has been continued. As an invaluable aid in this work should be mentioned the herbarium of New Jersey plants, collected and prepared through the efforts of Dr. B. D. Halstead, and recently put into usable condition by Miss Fiske, assistant seed analyst.

The following plants have been received for identification in the fiscal year:

Common Name	Botanical Name	Source
Quack grass	Agropyron repens	Perth Amboy
Quack grass	Agropyron repens	Cape May C. H.
Yellow foxtail	Setaria glauca	Plainfield
Black oat grass	Stipa avenacea	Newton
Crow-foot grass	Dactyloctenium aegyptium	Trenton
Florida paspalum	Paspalum floridanum	Cape May C. H.
Barnyard grass	Echinochloa crus galli	Cape May C. H.
Redtop panicum	Panicum agrostoides	Cape May C. H.
Horsetail	Equisetum arvense	Swedesboro
Horsetail	Equisetum arvense	Freehold
Hedge mustard	Sisymbrium officinale	Cape May C. H.
Dodder on pepper	Cuscuta sp.	Newfield
Germander wood sage	Teucrium canadensis	Newton
Galinsoga	Galinsoga parviflora	Norristown
Galinsoga	Galinsoga parviflora	Eatontown
Canada thistle	Cirsium arvense	Beateystown

EXPERIMENTAL WORK

In a sense every analysis of a sample of seed constitutes an experiment, the results being expressed in terms of purity or germination. Collectively, these results may be studied statistically or otherwise and somewhat definite conclusions may be drawn. However, it is seldom that the routine work of the laboratory is viewed in this light. There are definite problems which arise in connection with the laboratory work that are constantly receiving attention to the end that the analysis may be more accurate. The amount of time that can be devoted to such work depends upon the available hours over and above the time needed for the regular analytical work. Under the above heading may be grouped the following discussions:

1. The Composition of Some Lawn-grass Mixtures.

Mixtures of grasses and clovers for seeding lawns may not be agricultural seeds in the sense in which the term is generally used,

Table 2
Analysis of Lawn Grass Mixtures

Laboratory Test Number	Per cent of Inert Matter	Per cent of Weed Seeds	Number of Kinds of Weed Seeds	Per cent of Kentucky Blue-Grass	Per cent of Canada Blue-Grass	Per cent of Redtop	Per cent of English Rye Grass	Per cent of Timothy	Per cent of Fescue species	Per cent of Wood Meadow Grass	Per cent of Crested Dog's Tail	Per cent of White Clover
2450	26.1	2.6	14	19.0	19.3	3.3	19.0	10.7	....	..	..	....
2684	34.2	0.8	7	35.2	....	6.1	....	12.1	....	..	..	6.6
2849	37.0	1.4	9	....	....	16.7	24.0	20.9	....	..	..	....
2890	23.7	3.7	8	44.6	....	12.7	....	....	16.3	..	..	....
2893	36.7	3.7	12	14.2	....	15.7	25.5	....	....	4.2	..	....
2946	16.2	0.6	9	27.8	....	26.6	17.6	3.7	....	..	3.0	6.5
2948	18.7	1.0	12	15.8	....	31.2	21.7	2.9	4.7	..	..	4.6
2949	9.1	0.4	7	21.0	....	25.0	35.0	2.0	3.0	..	4.5	....
2954	16.5	0.5	8	25.8	....	26.6	20.1	4.6	....	..	4.0	1.9
2968	25.2	2.8	6	8.0	....	56.3	....	....	8.2	..	..	....
2969	31.1	0.5	9	12.7	....	45.8	8.4	....	....	..	..	2.0
2995	23.1	2.4	10	20.0	....	52.7	....	....	....	..	..	1.8
5067	32.2	4.4	10	10.1	....	18.3	....	20.0	....	..	..	20.0
5068	22.0	0.8	11	29.0	6.1	7.8	21.6	3.6	....	..	..	....
5076	20.2	2.7	15	23.8	3.6	27.1	11.3	....	4.8	..	2.9	3.5
5077	42.2	1.5	9	25.8	....	9.7	13.7	....	4.0	..	3.1	....
5078	45.2	1.0	8	27.1	....	4.0	12.7	....	....	..	2.5	....
5079	39.6	3.0	18	21.7	....	4.0	16.5	....	11.4	..	3.8	....
5080	40.1	1.1	13	27.0	....	10.3	15.0	....	....	..	2.0	....
5089	46.6	1.3	12	31.5	....	3.1	12.1	....	2.4	..	3.0	....
5090	37.1	0.5	10	29.0	....	8.2	19.2	....	3.0	..	3.0	....
5265	9.0	0.2	3	38.1	....	13.1	....	17.9	....	..	..	12.9
5266	17.8	1.0	8	62.0	tr	1.6	8.4	6.0	....	..	..	2.1
5275	22.3	0.8	5	16.2	....	26.8	8.4	....	17.5	..	8.5	....
5276	23.9	1.7	10	31.9	2.7	5.5	21.3	....	5.0	..	8.0	....
5277	14.9	2.5	12	28.2	....	18.5	....	....	16.7	8.5	..	....
5278	10.0	0.60	9	1.4	....	13.7	36.0	0.2	31.8	4.9	..	0.3
5279	15.1	1.0	7	10.0	....	30.3	....	27.2	....	..	..	11.4
5280	25.0	0.5	11	12.0	....	20.5	38.0	....	....	..	..	3.7
5285	35.3	0.7	7	30.7	....	16.1	....	18.0	....	..	..	6.9
5328	9.4	0.6	8	30.7	....	24.2	25.4	....	....	..	..	9.4
5330	27.8	1.9	11	34.7	....	22.7	....	6.6	....	..	..	....
5340	5.6	0.4	7	30.3	....	38.0	....	20.9	....	..	..	....
5341	4.5	0.4	8	22.0	....	31.0	....	25.5	....	..	..	2.2
5356	36.2	0.6	8	4.0	....	30.1	11.1	6.0	2.8	..	..	7.8
5375	19.5	0.3	4	35.7	....	44.5	....	....	....	..	..	....
5421	21.1	0.8	8	4.5	....	26.4	47.2	....	....	..	..	....
5447	37.1	0.6	4	20.0	....	28.6	13.7	....	....	..	..	....
5470	11.7	1.0	5	22.5	....	47.8	....	6.0	....	..	..	0.6
5541	*11.5*	*40.89*	*5*	*21.39*	....	*21.39*	*32.83*	....	*9.54*	..	*2.48*	....

although the several ingredients are used singly as such. The trade in this class of goods is very extensive and in most instances is a very profitable venture for the vendor. Occasionally these mix-

tures are compounds of medium or low-grade lots of seed for which it would be difficult to find other means of disposal.

Examination of the analyses of the several samples as given in table 2 will indicate that the formulæ for these mixtures, as prepared by various parties, show little uniformity in the kinds used and even less in the proportions used. These mixtures are not recommended for any particular conditions, with the possible exception of those containing wood meadow grass, which are generally intended for shaded areas.

2. The Effect of Age on Seed Viability

To gain some information as to the rate and extent of loss of viability of seeds stored under laboratory conditions, germination tests have been made of timothy, red clover, alsike and alfalfa. In making purity tests the sample is separated into component elements of pure seed, foreign seed and inert matter. For possible future reference these separated elements are placed in manila envelopes which are sealed and stored in well aerated tin containers for protection from rodents. Such samples are therefore subject to the ordinary changes in temperature and humidity which may occur in the laboratory. From such samples, originally tested in 1913, ten each of the above-mentioned kinds have been selected for the present test. Two lots of 100 seeds each have been counted from those samples and placed under the usual conditions for germination tests.

Similar studies are being made of seed originally tested in 1914, 1915 and 1916. All samples used in this series will be retained under the conditions described and tested each year until the samples are exhausted or until other conditions warrant the discontinuance of the tests.

3. Studies of Commercial Legume Inoculants

In response to an urgent request by interested persons, this department was designated to gather samples of commercial legume inoculants. Thirty-two samples were collected and analyses were made by Dr. C. R. Fellers to determine the approximate number of living organisms in these cultures, their purity, and their ability to infect particular legumes as stated on the package.

The results of this study have been prepared for publication as

a technical paper, and will also be used as the basis for a circular on the general subject of legume inoculants.

The kinds of grasses which enter into a lawn mixture should be determined by the nature of the soil and the characteristics of the grasses themselves, especially in relation to their adaptations for various soil conditions and their ability to make a durable turf of uniform texture and color. Manifestly, for one who is sowing a more or less extensive area it would be logical to have the mixture especially compounded to meet the conditions of that area. Such procedure would also permit the purchase of high-grade seeds which in the beginning and end cost less than any of the ready-made mixtures.

REPORT OF THE DIVISION OF EXTENSION IN AGRICULTURE AND HOME ECONOMICS

Division of Extension

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John H. Hankinson, A.B., State Leader of County Demonstration.
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Margaret H. Hartnett, Home Demonstration Agent.
Margaret C. Hayes, Home Demonstration Agent.
A. M. Hulbert, State Leader of Boys' and Girls' Club Work.
Nelle Johnson, B.S., M.A., Assistant Home Demonstration Leader.
M. Ethel Jones, B.S., M.A., Assistant State Club Leader.
Helen E. Minch, Extension Specialist in Home Economics.
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Harriot Ware, B.S., M.A., Home Demonstration Agent
Carl R. Woodward, B.S., Editor.

Paul B. Bennetch, B.S., Demonstrator for Sussex County.
F. A. Carroll, Demonstrator for Mercer County.
Elwood L. Chase, B.S., Demonstrator for Gloucester County.
Louis A. Cooley, B.S., Demonstration Agent for Ocean County.
Herbert R. Cox, M.S.A., Demonstration Agent for Camden County.
Ellwood Douglass, Demonstrator for Monmouth County.
Harry C. Haines, Demonstration Agent for Somerset County.
William A. Houston, Assistant Demonstration Agent for Sussex County.
Lauretta P. James, B.S., Home Demonstration Agent for Mercer County.
Harvey S. Lippincott, B.Agr., Demonstrator for Morris County.
Robert D. Maltby, B.S., Demonstrator for Atlantic County.
L. F. Merrill, B.S., Demonstrator for Bergen County
Warren W. Oley, B.S., Demonstrator for Cumberland County.
Irving L. Owen, B.S., Demonstrator for Middlesex County.
George T. Reid, Demonstrator for Burlington County.
Albert Schaffle, B.S., Assistant Demonstration Agent for Atlantic County.
James A. Stackhouse, B.S., Demonstrator for Cape May County.
Eunice Straw, B.S., Home Demonstration Agent for Monmouth County.
Harold E. Wettyen, B.S., Demonstration Agent for Passaic County.
Carolyn F. Wetzel, Home Demonstration Agent for Bergen County.

Division of Extension in Agriculture and Home Economics

REPORT OF THE DIRECTOR

ALVA AGEE

When conditions are normal, our country's greatest need is a rural life that is prosperous, intelligent and attractive: when we are engaged in a war that we are waging for the liberty of ourselves and others like us, the most important material thing is an adequate supply of food for our allies and ourselves. In time of war or peace a worker in extension in agriculture and home economics has a peculiarly attractive field of service. If he has any right to leadership, and that must be based upon ability and willingness to serve others, he realizes that he is in touch with vital affairs and cannot lack opportunity of being worth to his country all that his ability permits. The men and women who are in New Jersey's extension work are to be congratulated upon the fact that their work counts for the utmost, and if their energy is expended to the limit and the work is thoroughly well done, the contribution is not small.

ORGANIZATION

The basis of organization of the division of extension has been stated in previous reports. By agreement, national, state and local funds, that may be available for extension service, have the direction of their expenditure placed in the hands of a single division of the state's educational endeavor, and the problem before the director is to accomplish the most possible good with the money that is avail-

able. Experience has shown that such accomplishment depends very definitely upon cooperation with all others whose fields of work may overlap in any degree, and upon such unity of action within the extension service that everyone, from the local community to the State Agricultural College, as a head, will be doing team work. The particular form of organization that has been adopted in New Jersey lends itself to such unity in the work.

Projects

The States Relations Service, at Washington, has done well to insist upon the organization of all endeavor in definitely stated projects, and the full acceptance of this counsel in the past has helped us to escape some waste. The best judgment of heads of departments in the Experiment Station and the College, of specialists, of county farm demonstrators and of the executive committees within the counties, that represent the best farmers, combined with the best judgment of the States Relations Service, is formulated in projects whose purposes and methods of work are clearly stated. There are certain things that may be done for the development of agriculture and rural life in our state that are more important than other things, and the statement of a project is a device to keep our understanding clear and to help us to our purpose until there is accomplishment. Anyone who has not studied the nature of our work should have his faith in it strengthened by the fact that most practical, successful farmers in the various counties have studied each proposed project for their county and have approved of it before time and money have been put upon it. Attention is called to the reports of the state leader in farm demonstration, the specialists, the state home demonstration leader and the state leader in boys' and girls' club work for information regarding the various undertakings and the results that have been secured.

Four Groups of Workers

The success of extension work depends upon the form of organization used and the efficiency of its staff. In New Jersey our extension scientists form four groups that work in close cooperation with each other and with the College and Station staff. Work has been made peculiarly easy for the director of extension, because the oversight within each group is unusually efficient.

County Farm Demonstration

As the report of the state leader shows, our county farm demonstration work continues to gain the approval of the people, and every agricultural county in the state, except two, is now organized. The method of organization is outlined in that report, and the point is emphasized that there is direct touch between the local community, through its representative in the county's agricultural council, and the State Agricultural College and Experiment Station, through the county demonstrator and specialists. Every demonstrator is a member of the College staff, and at the same time he has the counsel and direction of representative men throughout the county.

I ask a careful reading of State Leader Hankinson's report, which gives some index to the practical value of the work done. Our county demonstrators are making a record of performance of which the state may well be proud. They are not inclined to consider commercial opportunities that would pay larger salaries, but do value the willingness of their counties that they should come into some degree of leadership in all that is being done for the betterment of agriculture and rural life.

Special attention is called to that part of the state leader's report which relates to the strengthening of county boards of agriculture and their connection with farm demonstration offices. This most important feature has been devised by the state leader, in cooperation with the county men. The growth in efficiency of the state leader's work is one of the best developments of the year.

The Work of Specialists

The specialists attached to the extension office at the College have the counsel and direction of heads of departments in working out projects which are offered to the various counties, through the demonstration offices. A research, or teaching department, can do direct work with groups of people in whom they are interested, and yet it is done in an orderly way through the county demonstrator, who has extension work in charge within the county, or at least, with his assent and knowledge. While the director of extension occasionally exercises his right to decide that certain undeveloped localities in the state, in unorganized territory, should have attention, it is the rule that the research or teaching department carries out its own will through its specialists, and the interests of the state's agriculure are served.

This annual report includes reports from our specialists in orcharding, market gardening, agronomy and soil fertility, poultry husbandry and dairy husbandry. They are clear outlines of work that is most practical and is commending itself to the public. As county organization and demonstration work has covered the most of the state, the specialists render their assistance chiefly through cooperation with county demonstrators. The efficiency of this particular line of work grows greater each year, and has become an essential part of the extension service in our state.

Home Demonstration

Our extension work in home economics has been peculiarly acceptable to the people of the state, and its development is shown in the report of the leader. The food situation, as affected by the war, aroused such interest that it was impossible to meet the demands for lectures, demonstrations and advice. Home demonstration agents were placed in three counties prior to the appropriation of emergency funds by Congress, and Miss M. Anna Hauser, who has charge of home economics, became also state leader of such work. Later she also was appointed by the National Food Administration the home economics director of the New Jersey Food Administration, and upon the suggestion of the state representative of the National Food Administration she became chairman of the Home Economics and Food Administration Department for the Women's Committee of the Council of the National Defense. Her report shows that a considerable addition was made to the staff, and others are being added as the right persons become available.

Boys' and Girls' Club Work

New Jersey was slow in starting boys' and girls' club work, and chiefly because the way did not appear open to secure such oversight for each club during the year that there would be a certainty of accomplishment. It is wrong to organize young people in any endeavor when there is no reasonable certainty that they will continue in it to the end. During the past year our division of extension has entered into cooperative arrangements with the State Department of Public Instruction, through the adoption of a plan of work proposed by the state leader of boys' and girls' club work, and, while some excellent work with the girls had been done in past years, there is

now promise of greatly increased efficiency through good organization.

Emergency Work

The war necessarily brought interruption to our extension work in many ways. Some members of the staff went to war, and all who remain had thrown upon them a great amount of labor connected with emergency food production that interfered with care of established projects. However much we may value the systematic work that had been undertaken on well defined projects, its interruption is a minor matter. I am hoping that everyone may find time to push two or three of the established projects, in order that there may be something to return to when the present emergency has passed but the big consideration is that there was an organization most effective in character that could render immediate assistance to the nation in the time of its greatest crisis. All of the labor and money that has been put into extension work in the past would have been well expended if it had done nothing more than prepare us for the emergency service that is now laid upon us. The problem lying before each one is to do the most possible in production and conservation of food, and at the same time hold to a part of the systematic educational work that has been outlined, but it should not be a matter of distress to anyone that immediate service of all sorts should be given priority, and when the war has been won, each one of us will look back to that sort of work with greater pride than to any sure educational achievement. The fact remains, however, that leading educational projects should be maintained as nearly as war work will permit.

War Funds

The report of the state leader shows the organization of counties with emergency war funds. The value of demonstration work is so great that Congress made money available for the establishment of agricultural agents in counties that might not be willing to make the usual contribution. The emergency funds appropriated for support of home demonstration agents is liberal, and they are being placed in cities and counties as rapidly as proper persons can be found, and local people show a willingness to cooperate through some contribution to local expense.

The counties that are receiving assistance from emergency funds in support of farm demonstration and home demonstration agents will learn their value and should be ready when such appropriation ceases to provide funds for continuation of this service. When the war is over, the problem of greater food production and its conservation will continue insistent for many years to come.

Relationship

Within the last three years the United States Department of Agriculture and the various state colleges have made an earnest effort to perfect a scheme of organization that would prevent any overlapping in their work, and any possible friction. Agreements were entered into that provided for unity and harmony. The war has thrust great problems upon the national government as well as the states, and the creation of a national food administration and the appropriation of emergency funds to the national Department of Agriculture may have seemed at times to create a confusing situation, but it is a matter of pride with our New Jersey division of extension that it has sought to carry out the will of the national government in this great emergency, and to coordinate all of its endeavor with that of all other agencies to the one end that food might be produced and conserved. It is working in close touch with the state representative of the National Food Administration and with all others in authority, and only results count at this time.

The cooperative relationship with the State Department of Agriculture has strengthened our organization. There is a true field of labor for each, and they can be kept distinctive, while the two staffs work in closest harmony.

Changes in Agricultural Extension Staff

Appointments

1917.		
Jan. 1.	Helen E. Minch	Assistant girls' club leader.
Feb. 15.	Carrie M. Pimm	Specialist in home economics.
Mar. 1.	Howard F. Huber	Specialist in fruit growing.
Mar. 16.	Wm. B. Duryee	Specialist in farm management.
Mar. 16.	Ellwood Douglass	County superintendent of farm demonstration for Monmouth County.
Apr. 1.	Charles H. Nissley	Specialist in market gardening.
Apr. 9.	A. M. Hulbert	State leader in boys' and girls' club work.
Apr. 9.	Julian F. Miller	Specialist in fruit growing.
May 1.	Wm. H. Hamilton	Assistant state leader of farm demonstration.

May	1.	H. S. Lippincott	County superintendent of farm demonstration for Morris County.
May	1.	Frank A. Carroll	County superintendent of farm demonstration for Mercer County.
May	15.	J. A. Stackhouse	County superintendent of farm demonstration for Cape May County.
May	15.	Eunice Straw	Home demonstration agent for Monmouth County.
May	19.	Howard F. Huber	Demonstration agent for Gloucester County.
May	21.	Louis A. Cooley	Demonstration agent for Ocean Co.
June	1.	Harold E. Wettyen	Assistant demonstration agent for Cumberland County.
June	1.	Lauretta P. James	Home demonstration agent for Mercer County.
June	1.	Carolyn F. Wetzel	Home demonstration agent for Bergen County.
June	8.	Walter F. Kroemmelbein	Assistant demonstration agent for Monmouth County.
July	1.	Helen E. Minch	Specialist in home economics.
Aug.	11.	Nelle Johnson	Assistant home demonstration leader.
Aug.	27.	M. Ethel Jones	Home demonstration agent.
Sept.	1.	Regine Porges	Home demonstration agent for Passaic.
Sept.	10.	Harry C. Haines	Demonstration agent for Somerset County.
Sept.	20.	Margaret H. Hartnett	Home demonstration agent for Paterson.
Sept.	20.	Mabel A. Tallant	Home demonstration agent for Sussex County.
Sept.	24.	Charles Orchard Smith	Assistant state club leader.
Oct.	1.	M. Ethel Jones	Assistant state club leader.
Oct.	1.	Josephine Cramer	Home demonstration agent for Middlesex County.
Oct.	1.	Robert D. Maltby	County superintendent of farm demonstration for Atlantic County.
Oct.	8.	Herbert R. Cox	Demonstration agent for Camden Co.
Oct.	15.	Harriot Ware	Home demonstration agent.
Oct.	20.	Margaret C. Hayes	Home demonstration agent for Morris County.
Nov.	1.	Elwood L. Chase	Demonstration agent for Gloucester County.
Nov.	1.	W. A. Houston	Assistant demonstration agent for Sussex County.
Nov.	1.	Albert Schaffle	Assistant demonstration agent for Atlantic County.
Nov.	15.	Harold E. Wettyen	Demonstration agent for Passaic Co.
Dec.	1.	Walter C. Vail	Demonstration agent for Salem Co.

Resignations

1917.			
Mar.	15.	Wm. B. Duryee	County superintendent of farm demonstration for Monmouth County.
Mar.	15.	Ellwood Douglass	County superintendent of farm demonstration for Atlantic County.
Mar.	31.	A. M. Goodman	County superintendent of farm demonstration for Morris County.

Apr. 11.	Wm. H. McCallum	State leader in boys' club work.
Apr. 30.	George B. Thrasher	County superintendent of farm demonstration for Cape May County.
Apr. 30.	Wm. H. Hamilton	County superintendent of farm demonstration for Mercer County.
May 18.	Howard F. Huber	Specialist in fruit growing.
June 30.	Helen E. Minch	Assistant girls' club leader.
Aug. 17.	Julian F. Miller	Specialist in fruit growing.
Sept. 9.	Harry C. Haines	Assistant specialist in fruit growing.
Sept. 30.	Walter F. Kroemmelbein	Assistant demonstration agent for Monmouth County.
Oct. 11.	Howard F. Huber	Demonstration agent for Gloucester County.
Oct. 12.	Lawrence G. Gillam	Specialist in fruit growing.
Oct. 20.	Fannie F. Cooper	Assistant state club leader.
Oct. 31.	Carrie M. Pimm	Specialist in home economics.
Oct. 31.	Elwood L. Chase	County superintendent of farm demonstration for Passaic County.
Nov. 15.	Harold E. Wettyen	Assistant demonstration agent for Cumberland County.

Publications

Bulletins

No. 10, December, 1916. Director's Annual Report. 71 p.

No. 11, February, 1917. The Improvement of the Poor Soils and Run Down Soils in New Jersey. 31 p.

News Letters

Vol. 4. No. 1, to Vol. 4, No. 52.

Farm Demonstration Exchange

Vol. 3, No. 1, to Vol. 3, No. 11.

The demand for extension publications dealing with food production and conservation was greater than the division of extension could meet, and by arrangement with the State Department of Agriculture the following publications were issued by it, with proper credit to the extension staff:

Circulars

No. 4, The Home Vegetable Garden.
No. 5, Plant Corn.
No. 6, Some Practical Suggestions.
No. 7, War-Time Rations for the Poultry Flock.
No. 9, War Prices and Dairy Feeding.
No. 11, Protecting the Home Garden from Insects and Fungous Diseases.
No. 13, The Drying of Vegetables and Fruits.

Leaflets

No. 1, Good Road at Little Cost.
No. 2, Save Vegetables and Fruit for Winter, "Home Canning Instructions."

REPORT OF STATE LEADER IN FARM DEMONSTRATION

JOHN H. HANKINSON

Continued growth marks farm demonstration work in New Jersey during 1917—growth in the number of organized counties from 11 to 16; growth in the results in counties already organized.

Probably the most far-reaching accomplishment of the work this year is the reorganization of the county boards of agriculture on a community basis, according to the plan originated last year, and their assumption of local responsibility for farm demonstration work.

The survey of the labor needs of the farmers in organized counties, which resulted in apparently little direct help, owing to disturbed conditions, deserves special mention because it established the leadership in agricultural matters of county boards of agriculture and of county superintendents of farm demonstration. It showed that in a time of widespread hysteria farmers and their agents could cooperatively attack war problems in an efficient way.

The results this year have been made possible because of the cooperation of the county boards of agriculture and other agencies in the field and through the close and happy relations which exist in the division of extension under the leadership of Director Agee. The state leader wishes especially to commend the desire for service which exists among the county agents and extension specialists.

On May 1, William H. Hamilton, county superintendent of farm demonstration for Mercer County, came to New Brunswick as assistant state leader. Mr. Hamilton has been especially helpful in putting into effect better systems of records and reports, in helping new men organize their counties, in the publication of "The Farm Demonstration Exchange," of which he has taken entire charge, and in the institute work.

ORGANIZATION OF COUNTIES FOR FARM DEMONSTRATION

On November 1, 1916, eleven counties were organized for farm demonstration. On Nov. 1, 1917, sixteen counties were organized for farm demonstration, and not one of the old counties has given up the work.

Ocean County organized on a permanent basis and Gloucester, Somerset, Camden and Salem on the emergency basis. Warren and Hunterdon are the only agricultural counties in the state now unorganized.

When farmers in a county desire to begin farm demonstration work, they communicate with Alva Agee, state superintendent of farm demonstration. If the demand is sufficient Director Agee arranges for a hearing before the Board of Freeholders, at which he or the state leader, together with representative farmers, asks for a local appropriation of funds. Owing to the desire of the National Government at this time to have a county superintendent of farm demonstration in every agricultural county of the country, it is now possible to place an emergency agricultural agent in a county, provided the county will furnish an office, provide a means of conveyance, such as a Ford automobile, and pay for its maintenance, whereupon the salary of the agent, salary of the stenographer and all expenses except the above, are taken care of by the emergency funds.

Under the regular farm demonstration plan the county appropriates $1800, whereas under the emergency plan the appropriation will average about $800. As soon as the appropriation is made a man is appointed as quickly as possible. No man, however, is chosen before being passed upon by a representative committee of farmers.

Equipment Necessary for Office of Farm Demonstration

The following is a list of equipment recommended for a county office, including a list which, though perhaps not essential, is, we consider, most desirable. The latter equipment, if funds are limited in the beginning, may be purchased from time to time as more resources are available:

Office desk and chair.
Stenographer's desk and chair.
Typewriter.
Bookcase or shelves.
8 chairs.
2 wire letter trays.
24 bulletin cases.
Road map.
Filing cabinet; 2 letter file drawers; one for correspondence and one for miscellaneous subject matter.

One section of four 4x6-inch card file drawers for
- Farmers' index by communities.
- Bulletin index.
- Miscellaneous subject index of farm visits and letters.
- Photographs and lantern slides.

One 3x5-inch card file for alphabetical mailing list.
One 9-inch card index tray for 4x6-inch cards for follow-up tray.
One set 4x6 guide cards by months for follow-up tray.
60 five-cut 4x6-inch guide cards for follow-up tray.
2 sets 25 subdivisions, letter-size alphabetical index guide cards for letter files and miscellaneous subject matter.
30 center of 3-cut 4x6-inch guide cards.
100 end of 3-cut 4x6-inch guide cards (for bulletin index and miscellaneous subject index).
25 three-cut 4x6-inch guide cards (index of farmers by communities).
1 set 25 alphabetical 3x5-inch guide cards for mailing list.
100 letter folders.
500 4x6-inch cards ruled.
500 3x5-inch cards ruled.

Desirable Office Equipment

Mimeograph.
Large reading table.
Chart printing or stenciling outfit.
Soil auger.
Soil acidity tester.
Camera.
Stereopticon.
Steel tape.

The make of car in use in New Jersey on the whole seems satisfactory. We believe it is a good plan to turn in a car at the end of 2 years; we also believe that a two-seated machine (all things considered) is more serviceable than a runabout, provided the added initial expense can be met.

Beginning the Work

The first efforts of the county superintendent of farm demonstration are directed to learning the problems of the county and to outlining two or three primary projects which would help toward their solution. The quickness with which he can meet the farmers of the county and learn local conditions and his ability to help the local men work together, are the measures of his initial success.

As soon as a county superintendent of farm demonstration is ready to go into a county, a representative committee of about 9 farmers is formed. This committee may be the executive committee of the county board of agriculture, or a special committee appointed or elected by the board, or it may simply be a group of farmers who are interested in the work and are leaders in their own communities. This committee then meets with the state superintendent or the state leader, and the county superintendent of farm demonstration, to discuss plans of work. The committee determines at its first meeting the community centers in the county and selects a leader for each, to which the county superintendent of farm demonstration may go for cooperation when working in that section.

Securing County Superintendents of Farm Demonstration

During the year 5 men had to be found for new counties, while changes in the old counties made it necessary to secure men for Atlantic, Cape May, Gloucester, Mercer, Monmouth and Morris counties. Of course, many of the changes in the old counties were due to the war and emergency conditions.

Qualifications of County Superintendents of Farm Demonstration

"The average county superintendent of farm demonstration in the northern and western states is a married man, 31 years old; graduate of an agricultural college, and has had experience in the ownership or management of a farm."

One of the problems in this work, as in any other work, is to secure good men, and although the department believes itself fortunate in men in the field, it feels that with the increase of extension work throughout the country, and especially in these war times, the demand will be greater than the supply. It is not every man that combines the qualifications necessary for a successful county superintendent. It is therefore both with a desire to develop new men, and with the thought that new men can be tried out before given the responsibility of a county, that we would suggest (1) that a course at the agricultural college be given in county agent work and (2) that at least 3 assistant county agents be employed in the state every year.

THE COUNTY BOARD OF AGRICULTURE

The far-sighted men who first planned the board of agriculture system of New Jersey devised a great democratic association of farmers for the promotion of agriculture. The point of view of these men was democratic, in that any man or woman interested in agriculture could become a member and vote for representatives to the annual convention which elects the State Board. It was efficient because it provided for expert executives responsible to the Board. It was wise because it provided for cooperation with the Grange and other existing farmers' associations. A working democracy was its ideal.

On this foundation and with this same ideal the plan of county board reorganization, suggested last year, was built. The change was made necessary by the changing conditions in our country. To-day our people are doing cooperatively through the Government many things which used to be left to private initiative. Other interests in the country also are organizing, so that from many points of view it is important that farmers come closer together and further develop the county board.

The adoption of the plan by the 11 organized counties during the past season is the best testimony of its appeal to our county leaders. The important features of the new plan are the assumption of local responsibility for farm demonstration work by the county boards and the formation of a working committee in each community of a county.

Its strength lies in the fact that it provides a method for the common counsel and common action of the agricultural interests in the community, in the county and in the state. The county board of agriculture is the only public institution in its field; therefore it is the best instrument in the county for this purpose.

Suggested Constitution and By-Laws

CONSTITUTION AND BY-LAWS FOR COUNTY BOARDS OF AGRICULTURE IN NEW JERSEY

Article I—Name

The name of this organization shall be the County Board of Agriculture of ———— County.

Article II—Object

The object of this board shall be to upbuild the agriculture of ——— County. It shall study and demonstrate better methods for the production and marketing of crops, livestock and stock products and for the improvement of the farm home.

Article III—Membership

Any man or woman interested in the objects of the organization may become a member on the approval of the executive committee.

Article IV—Officers

The officers of this board shall consist of a president, vice-president, secretary and treasurer, all of whom shall be elected by ballot at the annual meeting for the term of one year, or until their successors are chosen.

Aritcle V—Local Extension Workers

The county superintendent of farm demonstration, or other paid local extension workers, shall be the agent, or agents, of the board in conducting extension work in the county.

Article VI—Executive Committee.

The executive committee shall consist of 14 (or 18) members, 7 (or 9) men and 7 (or 9) women, elected as follows:

The president, vice-president, secretary and treasurer shall be ex-officio members, and the other members shall be electd by the county council.

Article VII—County Council

The county council shall consist of the chairmen of all community committees as hereinafter provided for, the county superintendents of schools, three delegates at large elected by the board itself and one or more representatives from county organizations that desire to be represented and that are approved by the board (such as pomona granges, livestock associations, interested business and bankers' associations). Officers of the board shall be ex-officio member of the county council.

Article VIII—The Community Committee

Section I. A community agricultural committee and a community home economics committee shall be formed in each community of the county. These committees shall consist of not less than three nor more than nine members resident in the community.

Section II. These committees shall be elected annually by the members of the county board in their respective communities at any local meeting at which elections may be held, of which due notice has been given. The term of office of community committeemen shall be one year, or until their successors are chosen.

Article IX—Election of Delegate

The election of delegates to the annual meeting of the State Board of Agriculture shall be held at the annual meeting of the county board; these delegates to be elected according to law.

Article X—Duties of Officers and Committeemen

Section I. The president shall preside at all meetings of the board, of the county council and of the executive committee. In conjunction with the treasurer he shall sign all checks and vouchers for the distribution of funds. He may call meetings of the executive committee, of the county council, or of any committee, whenever he deems advisable. He shall assign regular duties to the members of the executive committee.

The vice-president shall perform the duties of the president in his absence.

The secretary shall keep the records of the proceedings of the board, of the county council and of the executive committee.

The treasurer shall have charge of the funds belonging to the board and in conjunction with the president, shall sign all checks and vouchers for the distribution of funds.

Section II. The executive committee shall have control of the county office of farm demonstration, subject to the lawful supervision and approval of the state superintendent of farm demonstration, and such other work as may be taken up under the supervision of the board. The executive committee shall have power to fill vacancies as they may occur in any office or committee during its term of office and to transact any business of the board.

Section III. The county council shall be the chief agricultural and home economics advisory board of the county. It shall discuss recommendations made by the various community committees and shall recommend to the executive committee in writing a yearly county program of work. It shall be the duty of the county council to elect an executive committee as provided for in Article VI.

Section IV. The community committees shall represent the board in their respective communities. They shall help to arrange for meetings and demonstrations, cooperate as far as possible with the county superintendents of farm demonstration, or other local extension workers, in their work, and shall secure local memberships in the board. The chairmen of these committees shall submit the recommendations of the committees to the county council and shall make written reports of the annual meeting of the board of work accomplished in their communities.

Article XI—Meetings

Section I. The regular meetings of the county board of agriculture shall be held quarterly during the months of February-March, May-June, August-September, November-December, at convenient places.

All meetings shall be open to the public and it shall be the duty of the executive committee to arrange for interesting programs for these meet-

ings. The November-December meeting shall be the annual meeting. Special meetings of the board may be called upon the order of the executive committee.

Section II. The executive committee shall, unless there is nothing of *importance to consider, hold regular monthly meetings at such places and* hour as may be named by the president.

Section III. The county council shall hold an annual meeting on the —— day of December (or January). At this meeting an executive committee shall be elected and definite recommendations for work for the ensuing year shall be drawn up. Other meetings may be called by the president.

Section IV. The chairman of the community committee may call meetings of his committee at such times and places as he may deem advisable, by notifying members of the committee; joint meetings of the agricultural *and home economics committees* may be *held to discuss problems* of common interest.

Article XII—Finances

No dues are necessary, but this shall not restrain the executive committee from asking for voluntary contributions for special purposes, if such action seems desirable, or even providing for dues.

Article XIII—Quorum

Section I. Twenty-four members shall constitute a quorum for all meetings of members of the board. Four members of the executive committee shall constitute a quorum for all meetings of the executive committee.

Article XIV—Standing Committees

Section I. Standing committees of the executive committee of this board shall be appointed by the president as hereinbefore provided for (Article X, Section I) in order that the work of the board may be efficiently carried out. For the most part these committees shall consist of only one member, and shall be chosen from the members of the executive committee.

The women members of the executive committee shall be a standing committee on home economics work, and the men of the executive committee shall be a standing committee on agricultural work.

Article XV—Order of Business

The order of business shall be as follows:

1. Call to order by the president.
2. Reading of minutes of previous meeting.
3. Report of the secretary.
4. Report of the treasurer.
5. Report and recommendations of the county superintendent of farm demonstration.
6. Unfinished business.

7. New business.
   Adjournment.

(For annual meetings only)

1. Annual reports of officers.
2. Annual reports from communities by community committee chairmen.
3. Annual election of officers.
   Adjournment.

Article XVI—Amendments

This constitution may be amended by a two-thirds vote of the members present at any regular or special meeting. Notice in writing of the proposed changes shall be given to all members of the board at least two weeks previous to the time of the meeting.

How Reorganization is Accomplished

Before reorganization can be effected satisfactorily in new counties a county superintendent must be on the ground, and a representative committee of farmers in existence. A list of community centers has probably been made and a leader appointed in each. The committee then meets and appoints a committee to draw up necessary amendments to the constitution and by-laws of the county board, or requests the proper officials of the board to do so. A meeting of the entire board is then scheduled for some weeks ahead. The county superintendent, together with one member of the farm demonstration committee, or in some cases the president of the board, then confers with the community leaders, explaining to them the reorganization plan and asking them to come to the meeting of the county board and bring out their neighbors. Every community, as a rule, is visited before the county meeting. At this meeting the following procedure is followed:

1. Report of constitution committee.
2. Adoption or rejection of committee report.
3. Enrollment of members under the new plan if adopted.
4. Reports of community leaders on local problems.
5. Confirmation of list of community centers and of organizations which should be represented on the county council.
6. Election of officers.
7. Continuance of farm demonstration committee until executive committee can be regularly chosen.

8. Speeches.
9. Adjournment.

During the two months following this meeting a membership campaign for the county board is carried out and a series of community committee meetings held. At these the committee elects a delegate to the county council, and outlines the needs of the community. When the time for these meetings has elapsed the first meeting of the county council is held. At this meeting reports of delegates are given, an executive committee is elected and the program of work is decided upon.

Suggested Program of Work for County Boards of Agriculture

In general the work of the County Board of Agriculture may be divided, as far as this report is concerned, into organization and demonstration work. These two lines of effort are dependent one upon the other. A strong organization is necessary in order to secure the adoption of the best agricultural practices brought out by demonstration, and a good program of demonstrations along the important lines of the agriculture of the county will give the organization a definite piece of work to do. The county board, however, has a field as wide as the interest of the county in which it exists. At this time it is destined to carry out an important part in the emergency work.

The following program is based upon the peace-time experience of the past year and includes a monthly meeting of the executive committee:

November, December. *Organization*

A meeting is called in each community in the county by the chairman of the local community committee. At these meetings the results of the previous year's work in the county and the community are discussed; recommendations for the succeeding year's work are made and a committee is elected. Such meetings may be made a part of local institutes, or may be held in cooperation with an open meeting of the local Grange.

A membership campaign is conducted during these two months through the community committees. The annual meeting of the County Board is held during the latter part of November or the early part of December.

Demonstration work is carried on in dairy feeding, winter egg production, or perhaps pruning demonstrations may be held on good days. Some time is spent securing final results of demonstrations that have been initiated in previous years.

January, February. *Organization*

Final results of the membership campaign are announced. The county council meeting is held early in January, at which a program for the ensuing year is outlined, and an executive committee is elected. A series of community committee meetings is held to adapt the program of work to the various communities, to select cooperators, and to plan tentatively for local demonstration and field meetings in the community for the year. Several institutes, or important district meetings of the county board are held under the new plan, by which the board takes practical charge of the meeting and helps make it a success. Such meetings may also be held during November and December. A meeting of the county board is held in late February, at which the program of work for the year is explained and a few good speakers on the important lines of work are obtained.

Demonstration. Time is given to dairy work, such as feeding and judging demonstrations, and record associations; starting swine and orchard demonstrations; farm management demonstrations, and farm accounts; holding pruning demonstration meetings; following up poultry demonstrations, and securing final results from orchard and swine demonstrations that had been started in the previous year.

March, April.

The work of the organizations for these two months consists mainly of the community committees assisting in starting field demonstrations. Demonstration work is taken up in placing potatoes in cold storage for late-crop seed production; arranging for corn variety and fertilizer tests; spring seeding of alfalfa; arranging for soybean or cowpea demonstrations, and assisting in the field work of boys' and girls' clubs.

May, June. *Organization*

In May plans for the summer inspection tours and field meetings are made. The distribution of demonstrations is carefully studied by the executive committee. In June the annual inspection tour of demonstration is held, taking the place of the June meeting of the county board. Plans are made for the fall picnic or field meeting.

The demonstration work consists chiefly in following up work already started, and in starting work on cover crops and potatoes.

July, August.

The time is devoted mainly to following up and getting results from demonstrations, such as potato, alfalfa and soil fertility tests. Field meetings are held at demonstrations, and demonstrations are given in poultry caponizing and culling. Peach packing schools are held. Lime and alfalfa demonstrations are started. Some time is given to field work with boys' and girls' clubs.

September, October. *Organization*

The fall meeting of the county board is held. This is more of a picnic meeting, featuring boys' and girls' club work, games, contests, etc. Plans

are made for institutes, winter community meetings, the annual meeting, and the membership campaign. Local field meetings are held at corn variety tests, orchard demonstrations, etc. Some time is given to fair exhibits.

In demonstration work most of the time is devoted to securing results from work previously started, such as soybean, cowpea and alfalfa demonstrations, and corn variety, fertilizer and potato tests. During September poultry culling demonstrations are held and arrangements are made for winter egg production demonstrations.

Records and Reports

The county superintendent of farm demonstration is essentially a field man. However, certain records and reports are necessary in order that his work be done efficiently and the results of the work be secured. The system of record keeping in New Jersey covers an alphabetical correspondence file, an alphabetical miscellaneous subject file; a card index of farmers, showing name, address, locality, community center, soil type, crop, acreage and leading interest, filed by communities; a card index, by subjects, of completed follow-up cards; a bulletin card index; an indexed file of photographs and lantern slides, and an alphabetical card mailing list of farmers.

The work of the county superintendent of farm demonstration may be broadly divided into project work and miscellaneous work. The project work embraces all that which is planned in advance, and which is definitely outlined before being undertaken. Under miscellaneous work is classified assistance given farmers, or groups of farmers, on request. All important oral advice, or suggestions, whether given in the office, field, or by telephone, are confirmed by letter, a copy of which is placed on file.

In keeping records of project work, an outline for each project is made, showing the name, object and method of work. Each project outline is separate, and all information pertaining to that project is put together. A record of each demonstration in a project is kept, showing the name of the project, name, address and community center of the cooperator; meetings held at the demonstration, number of people inspecting the demonstration, and data on vital points.

In keeping the record of miscellaneous work a card is used in a follow-up file for each individual to whom assistance of any importance is given. This card shows the man's name, address, nature of

inquiry, date of inquiry, nature of assistance and date when follow-up shall be made. Such inquiries are then followed up when due by a visit or telephone call, to see whether further help is needed and to secure results. The cards are afterward filed according to subject matter.

County superintendents of farm demonstration make weekly reports to the state leader of farm demonstration, showing for each day of the week type of work performed, number of farmers visited, number of demonstrations visited, office calls, telephone calls, and meetings held or addressed; also the weekly total of letters written, number of circular letters mailed, number of articles published, and number of bulletins distributed.

Monthly project reports are made to the state leader, showing number of cooperators in each project, number of cooperators visited, and information concerning the progress of the project as a whole. These weekly and monthly reports are tabulated and studied in the central office, in order that an understanding of the work throughout the state may be secured, and in order that helpful suggestions may be made to the county men. From these reports the state leader prepares a monthly report by counties for Director Agee and for the United States Department of Agriculture. These reports are also made the basis of the "Farm Demonstration Exchange."

County Agent Conferences

In order that helpful experience in one county may be of use in another, and for the purpose of common counsel, quarterly conferences of county superintendents of farm demonstration and extension specialists are held at the College of Agriculture, New Brunswick. These usually take about two days; the last conference, however, included one day in addition for committee meetings.

The committee plan which was started last year has been continued and developed during the present season, the idea being to place responsibility for progress in the work squarely in the hands of the men themsleves, and through a selected system of committee appointments to have each committee carry the strongest men on the subject to be considered. Each committee usually includes the specialist who has that subject in charge.

The duty of the committee is to consider the reports of the work going on in the state along their line and to criticise and suggest new methods and projects. The committee then reports at the conference and a general discussion of its recommendations is made.

One of the features of the conference is a dinner to which members of the faculty are invited as speakers. This gives heads of departments a chance to put before extension workers any message which they may have.

The conference is also a good place for other leaders in our state to meet with the county agents in a body. During the past year Lewis T. Bryant, commissioner of labor, State of New Jersey; Lewis H. Carris, assistant commissioner of education, State of New Jersey; L. R. Simons, organization specialist, U. S. Department of Agriculture; Edwin Bebout, executive secretary, U. S. Food Administration, and H. E. Babcock, county agent leader, New York, addressed the conference.

The Farm Demonstration Exchange

The "Farm Demonstration Exchange" is a 4-page printed circular, issued monthly, on the work of the county superintendents of farm demonstration. It is made up from the monthly project reports, and occasionally contains special articles. Such articles have been furnished by the director of extension, the state leader, the extension specialists and professors at the college.

Mapping and Charting County Agent Work

One of the important factors in the activities of the office of farm demonstration is the distribution of the work within the county. In order that this distribution may be visualized and the work seen in its entirety, not only by the county superintendents of farm demonstration, but also by the farmers, a method of mapping and charting work was found necessary. Thus far Mr. Hamilton has provided blue-print maps showing roads and towns for the following counties: Sussex, Morris, Middlesex, Passaic, Mercer and Gloucester. A map was made for Monmouth County by the assistant superintendent of farm demonstration, Walter F. Krommelbein, and for Cumberland County by assistant superintendent of farm demonstration, H. E. Wettyen. The making of maps for the remaining counties will be completed as fast as possible. On these maps are plotted by means of small stickers of various shapes and

colors, the location of cooperators in the various lines of demonstration work being undertaken in the county. This gives a graphic presentation of the distribution of demonstration work. In addition, the location of executive committeemen, county councilmen, and community committeemen are plotted in order to show the thoroughness of the organization directing the work in the county.

Value of Extension Specialists in Making Extension Work More Efficient

In New Jersey the director of extension is also state superintendent of farm demonstration. Both extension specialists and county superintendents of farm demonstration are responsible to him. It is, therefore, easy for the projects of the county superintendents to be referred to the extension specialists for their review and assistance, and for the projects of the extension specialists to take into consideration the help which the county agents may render.

The extension specialists and county superimtendents come together at quarterly conferences and in the conference committees; thus the county work is really planned together. Beginning with October, the monthly project reports will be made in duplicate and a copy sent to the extension specialists.

The specialists will then make regular recommendations to the state leader in regard to the improvement of projects. During the past year informal suggestions of this character have been of great assistance.

State Meeting of Boys' and Girls' Agricultural Clubs at New Brunswick

The regular meeting of boys' and girls' agricultural clubs was conducted last December under the direct supervision of William H. McCallum, state leader in boys' club work. The attendance was slightly larger than for the previous year and the program seemed to interest the boys and girls. The county Y. M. C. A.'s, as usual, made this an occasion for a two-days' trip to New Brunswick for the boys in their county contests. A. M. Hulbert, the present state leader in boys' and girls' club work, has entirely taken over this work and is making great plans for the meeting this winter.

Home Economics Work

Home economics work has now grown so large that it has become a separate undertaking of the division of extension, under the con-

trol of Miss M. Anna Hauser, state superintendent of home demonstration.

In Bergen, Mercer and Monmouth counties, where regular home demonstration agents are now installed, the work was made possible through the efforts and cooperation of the county superintendents and county boards of agriculture.

In Mercer and Monmouth counties last season's campaigns and this year's efforts helped to secure local funds. In Bergen County, Mr. Merrill, county superintendent, and leaders in the county board were instrumental in arousing sentiment for a generous appropriation on the part of the local board of freeholders. In the remaining counties, where emergency home demonstration agents are being placed, county superintendents have taken an active part in starting the work and making it effective.

Farmers' Institutes

Farmers' institutes in New Jersey are a part of the work of the State Department of Agriculture. In the interest of coordination the state leader of farm demonstration has been made director of farmers' institutes, in order that these meetings may be closely knit with the work of the county superintendents and with the efforts of the county boards of agriculure.

In organized counties these meetings are being held under the direct auspices of the county board of agriculture, with the expert assistance of the county superintendents. About 65 or 70 meetings are planned for the coming season, averaging about three to a county.

Results of Project Work

The work in the respective counties during the past year is taken up later in this report. In addition, we are including tabulations showing the number of demonstrations conducted in each county and the number of cooperators in each. The scope of work, however, will perhaps be better understood by a review of what is being done in each branch of agricultural endeavor.

Soil Fertility

The Experiment Station tells us that humus, or vegetable matter, is the great need of New Jersey soils. County superintendents of

farm demonstration have largely been concentrating their efforts on demonstrations in methods of soil improvement designed to meet this need. Mr. J. B. R. Dickey, extension specialist in soil fertility, with the help of the county agents, has located plots all over the state showing the possibilities of building up poor soils through scientific methods and largely by the addition of organic matter through cover or green manure crops. Demonstrations are being conducted in nearly all the counties to show the value of cover and green manure crops for the purpose of adding organic matter to the soil. The best cover crop for corn is still an open question in different parts of the state, and different crops and different rates of seeding are being tested out. Some work has been done along the line of better sods. The top-dressing of hay was kept somewhat in the background during the last year because of the high price of fertilizer, but the addition of clover and alfalfa in the mixture is being emphasized more and more. The use of lime has been strongly advocated, so that the soil could become more friendly to the clovers. Truog soil testers have been installed in almost all of the offices of farm demonstration, and the men have done valuable work with these testers in determining amounts of lime necessary to sweeten the soil on the individual farm. The use of acid phosphate alone and with manure also has been demonstrated.

Farm Crops

The chief work with farm crops during the past year has been with corn, alfalfa and potatoes.

The corn demonstration which received the most widespread support was the test to determine the best strain of corn in a community. The use of more fertilizer at this time of high-priced corn has been successfully shown in Gloucester and Sussex counties.

Methods of seeding alfalfa have been the most popular alfalfa demonstrations, but a great deal of work has been done in determining the best strain of seed for New Jersey. As this demonstration was conducted largely by Mr. Dickey, it will be reported by him. Some costs of production are being kept, and it is hoped that with such records the best manner of putting alfalfa into the farm rotation may be shown.

With potatoes the seed question, and especially the production of home-grown seed, has been taken up in Burlington, Mercer, Middlesex and Monmouth counties. Demonstrations of late-crop seed

have proved that this practice, so prevalent in the lower part of the state, is sound for the central part of the state. The testing of immature seed of the first crop is likewise under way, and although the past year's results did not prove very promising, the test will be continued.

The soybean is a crop that can be grown more widely in New Jersey, county work has shown. The use of the proper variety is a big feature in success.

Dairy

The greatest efforts along dairy lines have been made in forming dairy record associations. Better cows are essential if New Jersey expects to meet the high cost of producing milk. Dairy-feeding demonstrations and dairy meetings at the barns or in the fields have proved valuable in bringing the farmers in touch with the latest feeding recommendations, and in emphasizing the value of good stock. The use of home-grown calf meal is a minor project which has been quite successfully carried on in some counties.

Fruit

The profitable management of an orchard is a complicated proposition in these days of spraying, pruning and intensive methods of culture and marketing. The demonstration which has given the best results has been the orchard-management demonstration in which an orchard well taken care of throughout the entire year is used to show successful orchard methods. Financial records are kept, and field meetings are held at the orchard.

One of the successful minor projects of the season has been the use of lime-sulfur-glue spray instead of self-boiled lime-sulfur. From the tests made this summer it looks as if the new spray has come to stay.

Truck

The problem of the vegetable grower in combating insects and disease is a large one. Some of the most successful truck demonstrations carried out throughout the state have been along this line; for example, in the control of the onion maggot, and the stem rot in sweet potatoes.

The variety test of tomatoes begun under the direction of R. W. DeBaun and carried on by H. F. Huber in Gloucester County, has

done a great deal to point the way toward improvement in the great tomato industry in that section. An early tomato more smooth and better in quality than the Earliana would mean a great deal for Gloucester County.

Poultry

As with orchard work, the most popular poultry demonstration has been a management project, although it has seemed more difficult to carry through successfully. A round of culling demonstrations carried on by the poultry department in cooperation with the county superintendents during September and October have been very successful.

Organization

In addition to the help which has been given in the organization of county boards of agriculture, county superintendents have taken an important part in bringing farmers together for business cooperation. The great need seems to consist in devising working methods. The county superintendent is able from his connections with A. L. Clark, of the State Bureau of Markets, and with the Department of Agriculture, to secure expert assistance in this work.

In Middlesex County, County Superintendent Owen has done excellent work in introducing the Farmers' Cooperative Association of Mercer County more widely in his district. He has also assisted the hay and grain growers of the lower part of the county to come together for their mutual advantage and to the benefit of the industry.

In Monmouth County, County Superintendent Douglass has been of assistance to the Monmouth County Shippers' Association in the second year of their work.

In Mercer County, County Superintendent Hamilton, and later his successor, Mr. Carroll, have helped the Farmers' Cooperative Association in its continued progress this year, and also helped to start a Potato Marketing Association in the vicinity of Edgebrook.

In Passaic County, County Superintendent Chase helped start a cooperative buying association.

In addition to these associations a great deal of time and effort has been spent with the dairymen. The dairy industry has had a hard time during the past year. The increased cost of feed and labor have borne heavily upon it. Many cows have been sold, be-

cause the farmers could not continue to produce milk and pay the cost of production. At such a time it is very necessary for farmers to come together and learn from each other the conditions of the business and work together for a fair price for their milk. In fact, the welfare of the country demands just such action. County superintendents were invaluable in such a movement through the assistance which they could give to the leaders among the farmers. The service they rendered was notable in Sussex, Mercer, Monmouth, Burlington and Cumberland counties.

The work of county superintendents of farm demonstration is closely allied with that of the Grange. All the men are members of the Grange and a great deal of their speaking and publicity work is done through the Grange and with its cooperation.

SUMMARY OF FIELD DEMONSTRATION WORK BY COUNTY AGENTS IN NEW JERSEY, NOVEMBER 1, 1916, TO OCTOBER 31, 1917.
(Number of Demonstrations)

Counties	Soil Improvement		Field Crops						Livestock				
									Dairy				
	Cover Crops and Green Manures	Lime and Fertilizer	Alfalfa	Corn	Soybeans	Potatoes	Truck Crops	Orchard Work	Record Association Membership	Feeding Demonstrations	Poultry	Miscellaneous	Total
Atlantic	2	..	2	..	..	..	3	16	..	..	9	1	33
Bergen	29	..	12	..	..	2	6	5	16	..	7	..	76
Burlington	6	4	15	11	..	22	..	7	10	17	4	19	115
Cape May	5	..	4	1	2	..	19	13	..	..	5	10	55
Cumberland	3	..	6	1	..	..	12	17	15	..	14	5	73
Gloucester	..	30	12	5	..	..	34	2	..	..	..	..	83
Mercer	5	3	16	4	2	34	..	7	21	3	..	..	94
Middlesex	...	11	18	..	..	17	..	7	20	..	3	..	76
Monmouth	..	..	..	..	..	76	..	14	..	5	..	3	98
Morris	9	..	22	..	12	..	..	3	..	6	5	..	57
Ocean	86	..	6	..	..	..	..	..	..	..	..	..	92
Passaic	..	..	9	..	..	4	15	1	18	..	7	4	58
Somerset	..	..	..	..	..	..	..	..	7	..	..	..	7
Sussex	..	35	124	2	11	..	..	19	39	6	9	..	245
	145	53	241	23	27	155	88	111	141	37	68	42	1156

Methods of Work

Personal Work

Although it is a physical impossibility for the county superintendents to visit every farmer in the county during the year, and

no such demand exists, there does exist a great field for personal work by the county superintendent. Group service is necessary for the best results. Demonstrations, meetings and publicity matter are all helpful and afford the greatest opportunity with the least expense. However, when a farmer honestly asks for information he is in the best position to receive help. When this request is along the line of the projects being carried out it is an unequalled opportunity to put into effect the teachings of the demonstration.

Demonstrations

As stated in the last paragraph, the greatest good cannot be accomplished without public demonstrations. In fact, the idea of demonstration distinguishes this kind of work from the old methods of bulletins and meetings. Demonstrations should be well chosen, well carried out and well advertised. The local meeting at a demonstration is a great means of education.

Publicity

How can the truths of the demonstrations be best brought to the people of the county? The local press perhaps stands first as a means for reaching the people. Circular letters addressed to special men, or the monthly letter of the office, giving results and progress, are valuable. The annual report of the office of farm demonstration published at the end of the year with all the facts of the work has a great place in publicity. After the demonstration meetings, auto tours which visit these demonstrations and exhibits of material from the demonstrations are valuable. Use of such exhibits at the winter institute meetings helps the program of the meetings and helps to press home the truth. The agricnltural press is a good medium for special articles to put out at the beginning of a campaign.

General Meetings

Meetings have an important place in this work. They bring the people together to know each other and to think better of each other. The county picnic and the county dinner are examples of meetings which have apparently no educational object, and yet have great educational value.

Recommendations

After reviewing the work of the past year the central office recommends (1) two or three big projects well chosen, well followed up, and well advertised. With less projects more time can and should be given to individual work. Some complaint has reached this office that county superintendents were so tied up with work that they did not have time to answer pressing inquiries of farmers.

(2) We would also recommend to the county superintendents and the executive committee of county boards the possibilities which exist in the community committee. We believe that great things can be accomplished through a larger cooperation with the community committee. This committee can do some of the work which is now done by the county superintendents, and do it better. It is to their interest to develop their own community and we believe that they would welcome a larger share of responsibility and activity in the work. There is no reason why outlines of projects not a part of the formal program of the year should not be useful in the hands of the community committee. For this reason community organization of the counties should be completed at an early date. More effective work can be accomplished through a complete organization, provided the organization is made to feel the responsibility that is its rightful due.

Emergency Work

The entrance of our country into the great war has naturally had a disturbing effect on the plans and projects of the county work. Under the national call to service which went out from Washington, no one could hold back, least of all the men engaged in agriculture. The first efforts to be of service were made through a series of meetings intended to arouse the counties to the necessity for increased food production. This was followed by urgent recommendations for the early purchase of supplies and the reports to the state and national governments of the needs of the farmers and the conditions on the farm.

The labor situation proved the greatest problem. A state-wide canvass of the labor needs of the organized counties was made in June. This canvass has been referred to above.

Recommendations

County superintendents and county boards of agriculture should plan now for next year's war work. They should urge first of all the reorganization of farms to meet war conditions by

1. Growing more crops which can directly or indirectly increase our exports of food-stuffs. Such crops will bring war prices. Charts showing the actual costs of production under war conditions are helpful.

2. The use of every labor-saving device known to the skillful farmer; for example, the use of larger teams.

3. The development of the labor supply through
   a. Paying as good wages as possible.
   b. Utilizing the local labor supply.

Even small farmers, retired farmers who understand country work, and country boys and girls, may be secured, provided arrangements are made in time. In sections where large numbers of transient help are needed, arrangements for taking care of them should be made in advance, as the usual sources of supply of this labor are being drained to the utmost. Arrangements for boarding extra men, either individually or by communities, should be thought of. Boys' camps are a possibility if it is possible to engage good boys before school closes. All this, however, under the present trying conditions needs a keen realization of our country's position.

A meeting to arouse patriotism is a fine thing; it is a finer thing, however, to demonstrate patriotism. Members of the farm demonstration forces and county board leaders demonstrate patriotism when they work to increase crop production by better farming methods; when they work to combat the inroads of pests and disease; when they work to help other farmers weather the trying conditions; when they cooperate with the national government to the fullest; when they sacrifice personal prejudice or sensitiveness to the common welfare. Our country needs the crops.

Atlantic County

Robert D. Maltby, County Superintendent

In March Ellwood Douglass resigned as county superintendent of farm demonstration to take charge of the work in Monmouth County. Robert D. Maltby, director of vocational schools in Atlan-

tic County, kindly took over the work that had been started by Mr. Douglass. With the assistance of his staff of vocational teachers he has carried on the demonstrations as outlined by the executive committee of the Atlantic County Board of Agriculture. On October 1, Mr. Maltby was appointed county superintendent of farm demonstration, having general supervision of farm demonstration work in the county, and was given Albert Shaffle as an assistant who will actually conduct a large part of the work.

On January 13 the Atlantic County Board of Agriculture was reorganized on a community basis and took over the local direction of the office of farm demonstration. The following officers were elected: John Huenke, president; Layton Parkhurst, vice-president; William Hohneisen, secretary; and J. L. Purzner, treasurer. Since that date 7 community committees have been organized in the county. In the organization of these committees President Huenke rendered valuable service. The projects that have been carried out are strawberry dusting, sweet potato seed selection, bee keeping, poultry, orchard, and soil improvement.

One of the biggest events for the farmers of the county this year was the annual fair held at May's Landing, August 29, 30 and 31. The fair was held through the cooperation of the Atlantic County Pomona Garage, the County Board of Agriculture, the Germania Fruit Growers' Union, the Landisville Fruit Growers' Union, the Poultry Associations, the Atlantic City Rotary Club, the Ventnor Board of Trade, the Atlantic City Hotelmen's Association, the Atlantic County Vocational Board of Education, Atlantic County Office of Farm Demonstration, and the Agricultural Improvement Club of Minotola. Mr. Maltby and his vocational staff worked hard in making this fair a great success.

On July 25 a market was opened in Atlantic City to enable producers to sell direct to consumers. The results showed that there was opportunity for a good market-place in Atlantic City; that the farmers can put up their produce in a suitable manner if there is some incentive to do so, and that the produce coming from Atlantic County is as good as from any other section of the state. It was also demonstrated that the people of Atlantic City will buy if the material is placed on sale in suitable quantity.

While there has been no outbreak of hog cholera in the county this year, a system was devised to prevent the spread of the disease.

Registry blanks were distributed in each community, which were filled out, giving the farmer's name, number of hogs and approximate weight, so that in case of an outbreak preventive measures could be taken.

Bergen County

L. F. Merrill, County Superintendent

On December 4, a joint meeting of the Bergen County Board of Agriculture and the advisory commtitee of the office of farm demonstration was held. At this meeting the two bodies were merged into one and reorganized on a community basis, under the name of the Bergen County Board of Agriculture. Arthur Lozier, president; J. J. Van Wagoner, vice-president; J. M. Meyers, secretary; T. V. Strohsahl, treasurer; and William Brandenberg, John Carlough, William Ehret, Jr., D. Y. Lewis, J. R. Van Houter and P. Westervelt, the executive committee of the board, have had local supervision of the work. Since December 8 community committees have been organized in the county.

Due to the campaign for food conservation, brought on by the declaration of war, the women of the county decided that a home demonstration agent was needed. The question was discussed at the May meeting of the board of agriculture, and a committee was appointed which secured the necessary funds for the work from the board of freeholders. Miss Carolyn F. Wetzel was appointed home demonstration agent and took up her duties June 14. This work is supervised by the woman's work committee of the board of agriculture, composed of Mrs. A. Z. Bogert, Mrs. R. E. Tawlin, Mrs. A. W. Leslie, Mrs. D. Y. Lewis, Mrs. W. T. Osler, Mrs. T. C. Robbins, and Mrs. Mabel Wood Tuttle.

Project work in orchard management, soil improvement, vegetable spraying, late-crop potatoes for seed, poultry, alfalfa, and a dairy record association were conducted in the county this year.

Eleven girls' canning clubs were organized with the assistance of Miss Fannie F. Cooper, state leader in girls' club work, with a total membership of 388. This work was turned over to the home economics department in June.

Besides the project work, much time was taken during the spring and summer in emergency work. A large number of meetings were

held in response to the demand for information on home gardens, and during the summer many calls were received for assistance in the control of plant lice, which have been very destructive throughout the county this year.

The office of farm demonstration cooperated in making the Bergen County Fair of value to the community. An automobile inspection trip also was conducted in the county.

Burlington County

George T. Reid, County Superintendent

On November 8, 1916, the executive committee of the Burlington County Farm Bureau decided to merge with the Burlington County Board of Agriculture and reorganize on a community basis. A committee was appointed to meet with a committee of the county board to discuss and make arrangements for such a consolidation. This committee decided in favor of the movement and prepared a resolution which was adopted by the county board of agriculture December 3, at its annual meeting in Mount Holly. At this meeting the following officers were elected: Edward E. Logan, president; J. A. Jones, first vice-president; J. V. Bishop, second vice-president; Edward Rogers, secretary; H. B. Wright, treasurer. Since this time 9 men's community committees and 6 women's community committees have been organized.

The project work recomended by the executive committee and carried out by Mr. Reid, through the cooperation of the county board and its community committees, has consisted of orchard management, poultry, dairy feeding, calf feeding, dairy record associations, better seed potatoes, cover-crop tests, alfalfa demonstrations, corn variety tests, and a boys' pig club.

In conducting the dairy-feeding demonstrations the office of farm demonstration purchased a number of milk scales which were loaned to the cooperators. From records that have come in it has been clearly shown that the feeding of a balanced ration, according to production, has materially decreased the cost per quart of producing milk.

In the work on better seed potatoes, tests were conducted on immature seed, late-crop home-grown seed and northern-grown seed. The results this year indicate that the late-crop is fully as good as, if not superior to, northern-grown seed, and that the immature seed

is better than the regular home-grown. However, no conclusions can be based on the results from one year's test. Good results are being obtained in producing late-crop Giants for seed purposes.

Besides the regular project work, the office of farm demonstration rendered assistance in the organization of the dairymen of the county in connection with the Inter-State Milk Producers' Association and in securing labor through the New Jersey and Pennsylvania labor departments for the farmers of the county. An exhibit was made at the Mount Holly Fair. Two automobile tours have been conducted in the county.

Camden County

H. R. Cox, Emergency County Agent

Camden County was organized for farm demonstration in October under the emergency act providing for emergency county agents. Mr. H. R. Cox began work in the county October 8. The local direction of the work has been placed under the supervision of the Camden County Board of Agriculture, which has appointed a farm demonstration committee to cooperate with Mr. Cox in his work in the county. The committee is composed of X. F. Ottinger, J. Watson Matlack, Everett Garwood, Benjamin Barrett, P. W. Beidermann, H. H. Bell, Charles Fell, A. H. Hurff, and Martin Schubert.

Cape May County

J. Archer Stackhouse, County Superintendent

George B. Thrasher resigned April 30, and was followed May 1 by J. Archer Stackhouse as county superintendent of farm demonstration. On December 22, 1916, a joint meeting of the Cape May County Board of Agriculture and the advisory committee of the office of farm demonstration was held to complete the consolidation of the county board and farm demonstration advisory committee. A constitution and by-laws was adopted providing for the reorganization of the county board of agriculture on the community plan, and the following officers were elected: Joseph Camp, president; Howard Hoffman, vice-president; R. Schellinger, secretary; Ralph

Taylor, treasurer. Since that date 12 community centers have been approved by the county board and community committees have been formed in each.

The work done in hog cholera prevention shows the value of such an organization. Due to the fact that several of the best veterinarians had been called to the front, it became necessary for the county superintendent of farm demonstration to take steps to control hog cholera in the county. This being the case, a member of each community committee was successfully taught how to inoculate hogs by the single-method treatment to prevent cholera. This has aroused a local responsibility and has gone far in teaching the value of inoculation. Since May 1, 1917, 270 animals have been treated; of these ten had the disease before treatment, and only seven of the entire number died. This year less than one hundred dollars' worth of animals died, compared with three thousand dollars' worth last year.

Projects carried on have been orchard management, work with vegetables, soybean variety tests, cover crops and bee keeping. The bee-keeping project has created a great deal of interest in the county. One cooperator has purchased $250 worth of new stock. Several of the cooperators have cleared $5.00 on a hive, which is about 50 per cent on the investment, and one man sold $15.00 worth of honey from one hive. In connection with this work a bee-keeping club, with 10 members, has been started. Plans have been made for an inspection trip of apiaries in the county.

Mr. Stackhouse was appointed a member of the committee on arrangements for the county fair, and devoted considerable time in making this of value to the farmers of the county.

Cumberland County

W. W. Oley, County Superintendent

On November 27, the Cumberland County Board of Agriculture at a regular meeting adopted the constitution and by-laws providing for reorganization on a community basis. The following officers were elected: Leslie Platt, president; Morgan Husted, vice-president; A. M. Seabrook, secretary; and Walter Shute, treasurer. Twenty-one communities were selected and thus far eight have been organized. A large number of lines of demonstration work have

been successfully carried on during the past year, including orchard management, spraying, pruning, top working, packing and marketing peaches and apples, winter egg production, February hatching, trap-nesting, soil fertility, corn breeding, alfalfa tests, growing sudan grass, meadow drainage, sweet potato seed selection, onion and beet maggot control, and organization of a dairy record association.

The onion-maggot control was eagerly taken up by the onion growers of the county. Besides the ten cooperators who made detailed reports, a great many men successfully used the treatment.

The office of farm demonstration has cooperated with the county superintendent of schools in conducting boys' and girls' club work in the county. Over 400 entries were secured.

An automobile inspection tour was held in July, and a county picnic in August, both of which were well attended.

Mr. Oley had the assistance of Mr. Watt from January 8 to July 8, who devoted most of his time to the dairy interests of the county, as he was employed cooperatively by the extension division of the State Agricultural College and the Bridgeton Condensed Milk Company, which paid all his salary. He also had the assistance of Mr. H. E. Wettyen from June 4 to September 22.

Gloucester County

H. F. Huber, Emergency County Agent

Gloucester County was organized for farm demonstration during May, in anticipation of the action by the Federal Congress providing for emergency county agent work. Mr. H. F. Huber was appointed emergency agent May 21. The local direction of the work was placed under the direct supervision of the county board of agriculture. The following farm demonstration committee of the county board was appointed to meet monthly with the county superintendent: Theo. Brown, James Carter, Asa Moore, Willard Gardiner, C. Fred Bateman, Wilbur Beckett, Herman Newkirk and John Wolfert. This committee appointed one representative, through which the county superintendent could work, in each of the 21 communities.

One of the first problems confronting Mr. Huber was that of labor, and he succeeded in placing a considerable number of men, through cooperation with the Pennsylvania state and federal de-

partments of labor. A number of boys' camps were established through the cooperation of the county and state Y. M. C. A.

In demonstration work the following projects have been conducted: a tomato variety test, cucumber beetle control, onion thrip control, the use of hydrated lime-sulfur-glue spray on peaches, corn variety tests, extra fertilization of corn, alfalfa variety tests, selection of sweet potato seed, use of lime, and alfalfa field demonstrations.

In controlling the striped cucumber beetle two men cooperated in testing out the use of lead arsenate alone (in liquid spray) and dusting with hydrated lime and tobacco, and sulfur and lead arsenate. The use of the lime and tobacco dust proved to be very efficient in acting as a repellent. Six growers in the vicinity of Williamstown watched these demonstrations critically all spring, and finally adopted this method in preference to their old method of turpentine, sand and gypsum.

The first season's work on a tomato variety test shows a considerable variation in size of fruit, vigor of growth, yield of marketable fruit and percentage of rough fruit. Although one season's test does not furnish a fair basis for comparing different strains, nevertheless these records give some idea of the character of the varieties. Twenty-nine of the 32 lots of seed were the early tomatoes grown by some of the leading growers about Swedesboro. The other 3 lots came from other sections. The different lots received the same fertilizer and cultivation throughout the season in order to allow nothing but inherent differences in seed to affect the yield. It was impossible to make distinctions between the various kinds with respect to earliness, as the blossoms on the crown were nearly all lost because of the cold weather during the early part of the season.

In order to make this test of real value, it should be repeated for two or more years. It is not likely that much benefit will be derived from endeavoring to secure a strain which will yield more or bigger fruit than the average grown in the section at present; but in respect to quality and smoothness of fruits, there is considerable room for improvement. It is of interest to note, in this connection, that the strain with the smallest percentage of rough fruit was not of the Earliana type, as are most of the strains grown in the section. This test has aroused a great deal of interest among the tomato growers in the county.

Mercer County

F. A. Carroll, County Superintendent

On May 1, F. A. Carroll was appointed county superintendent to succeed Wm. H. Hamilton. On December 19, a joint meeting of the executive committee of the Mercer County Farm Bureau and the directors of the Mercer County Board of Agriculture was held to consider the consolidation of the two organizations. On January 20, at a joint meeting of the entire membership of the two organizations, it was decided to combine and reorganize on the community basis, retaining the name "The Mercer County Board of Agriculture." The following executive committee was elected: William H. Blackwell, John C. Errickson, R. E. Haines, A. Crozer Reeves, F. W. Cruser, Leon Mount and John W. Hendrickson, Mrs. William H. Blackwell, Mrs. John H. Hankinson, Mrs. Charles E. Rue, Mrs. J. L. Herbert, Mrs. Thomas C. Hill, Mrs. R. E. Haines and Mrs. S. S. Hixon. Thirteen communities were recommended and a community committee has since been appointed in each of these communities. These communities have done much in advancing the work this year.

As a result of the home economics work that had been carried on in the county during previous years the women of the county felt the need of a home demonstration agent, and on March 7 the executive committee of the County Board of Agriculture unanimously decided to take steps necessary to procure such an agent. Local funds were raised by subscription and Miss Lauretta P. James was selected as home demonstration agent. She took up her duties June 18, under the supervision of the women on the executive committee.

The following lines of demonstration work were recommended by the executive committee: organization of a dairy record association, calf feeding, alfalfa growing, potato improvement, corn variety tests, extra fertilization of corn, orchard management, vetch seed production and boys' and girls' club work.

A dairy record association was organized in April with 14 members, which number has since been increased to 21.

In response to the demand for work with potatoes, 29 cooperators have planted potatoes for second-crop seed this summer, results of the previous year indicating the value of such seed.

In addition to the project work, a great deal of time was spent last winter and during this summer cooperating with the Inter-State

Milk Producers' Association in organizing the dairymen of the county As a result, the chairman of the county organization, who is also a member of the executive committee of the inter-state association reports that Mercer County is better organized than any other county in the association.

Some time has been given to the Mercer County Farmers' Cooperative Association, which has proven of great value to the farmers of the county. Assistance was also given to a number of potato growers in the vicinity of Edgebrook, who organized in order to establish a more efficient system of grading and marketing potatoes. A manager was hired and work so far has given excellent satisfaction. During the season much valuable assistance has been rendered in securing farm labor. The farmers in the vicinity of Robbinsville got together, through their community, and established a boys' camp. This would have been highly successful if it had been possible to secure a sufficient number of boys.

The office of farm demonstration cooperated with the public schools in conducting boys' and girls' club work. The direct supervision of this work was taken over this year by the county superintendent of schools and the four supervising principals. The county superintendent of farm demonstration, however, was on the club work committee and rendered as much assistance as time would permit in organizing and giving instructions to the clubs.

An automobile tour was held in connection with the alfalfa association field meeting at the Walker-Gordon farms.

Middlesex County

I. L. Owen, County Superintendent

At the joint meeting of the advisory board of the office of farm demonstration and the executive committee of the Middlesex County Board of Agriculture on November 18, the plan of combining the two organizations, and reorganizing on a community basis, was adopted and referred to the county board of agriculture. At the annual meeting of the county board, a constitution and by-laws was adopted, providing for such reorganization. The following executive committee was elected: John M. Evans, John Van Dyke, W. B Kurtz, David J. Perrine, George Davison, T. M. Applegate, George Redshaw and Lewis Walker. Since that date, 9 community committees have been organized. Orchard, poultry, potato, soil improve-

ment, alfalfa and dairy work have been taken up during the past year. In most cases cooperators were secured through the activity of the county committeemen.

A large number of men in the southern end of the county have felt that, through cooperation, they can secure better prices for their hay and grain. Consequently, the Central Jersey Producers' Association was organized during the summer. In organizing this association, assistance was rendered by the Bureau of Land, Crops and Markets of the State Department of Agriculture.

Early in the year the success of the Mercer County Farmers' Cooperative Association attracted the attention of Middlesex County farmers. The question of forming a similar association in Middlesex County was discussed by the county board. It was decided, however, that the organization already in existence could serve Middlesex County better than a separate association. Consequently, the executive committee recommended that the farmers become members of the Mercer County association. The community committee of the county board have secured many members for the association this year.

Emergency work has taken up a great deal of the time of the superintendent of farm demonstration. During April and May four tractors were placed at the disposal of the New Brunswick Home Defense League. The listing of land to be plowed and the general supervision of the work was placed under the direction of the county board of agriculture. At one time over a thousand acres of land was scheduled, although rainy weather and the late spring prevented the use of the tractors on the entire acreage.

The office of farm demonstration cooperated with the State Department of Labor; in fact, furnished the local office for the Labor Department, and succeeded in placing 45 men and 16 boys on farms in the county. In October an emergency home demonstration agent was placed in the county. A committee of women was called together to outline a program of work.

Monmouth County

Elwood Douglass, County Superintendent

On March 15, William B. Duryee resigned as superintendent of farm demonstration to accept a position as farm management specialist for the State Department of Agriculture. Mr. Douglass

was transferred from Atlantic County, and took up work immediately.

At the annual meeting of the county board of agriculture, held in December, the recommendations of the joint meeting of the farm demonstration advisory committee and the directors of the county board of agriculture to combine the two organizations were adopted. The following executive committee was elected: H. V. M. Dennis, E. A. Sexsmith, J. C. Richdale, B. L. Beckman, H. E. Taylor, C. D. B. Forman and Howard Woodward. Fourteen community committees have been formed in the county and have rendered valuable service in carrying out the program of work.

On June 1 Miss Eunice Straw was appointed home demonstration agent for the county, as a result of the great demand on the part of the women in the county. The necessary local funds were raised by private contributions.

The main projects this year were concerned with potato, dairy and orchard work. Under the potato work, 20 cooperators grew late-crop Virginia Giants in comparison with northern-gown seed. The average yield of the Virginia Giants was somewhat larger than that of northern-grown seed, and there were fewer small tubers produced. Twenty-one cooperators have compared late-crop home-grown seed with northern-grown seed. The yields from the home-grown seed have compared favorably with those from Maine and New York State seed. Besides these major demonstrations, minor tests have been conducted in extra applications of fertilizers; influence of the size of the seed piece on yield; comparisons between machine and hand-cut seed, comparisons of seed and stem end; and several tuber unit tests.

Early in the year a milk committee was appointed by the county board of agriculture. Through the efforts of this committee, the dairymen have been able to secure a fairer price for their milk. At a meeting in October they organized the Monmouth County Milk Producers' Association.

During last winter the office of farm demonstration, cooperating with the management of the Monmouth County Fair, appointed township secretaries for each township in the county. These secretaries met from time to time with Mr. L. T. Randall, manager of the fair, and the county superintendent of farm demonstration. They were active in arousing interest in their communities, and securing

exhibits from individual farmers. The success of this plan was made evident by the fact that there were 50 per cent more individual exhibitors this year than last. Besides this assistance given to the fair association, the office of farm demonstration made an extensive exhibit at the fair again this year.

Cooperating with the State Department of Labor, the office of farm demonstration has assisted in placing over 500 men on farms in the county. The Monmouth County Shippers' Association has been given assistance again this year. During the summer months, Mr. Walter F. Kroemmelbein has been of great value as assistant to the county superintendent of farm demonstration.

Morris County

H. S. Lippincott, County Superintendent

On March 31, A. M. Goodman resigned to take up work with the dairy division of the United States Department of Agriculture, and was succeeded on May 1 by H. S. Lippincott.

On December 9, at the annual meeting of the county board of agriculture, the community plan of organization was presented and adopted. Fourteen community committees have been organized and the following executive committee was elected at the March meeting: George E. Felch, Elber Bebout, Walter Garabrant, H. R. Hopping, Fred Mooney, W. R. Neighbor, and Louis Waxburg.

Demonstration work was started in orchard management, winter egg production, dairy and calf feeding, alfalfa growing, vetch seed production, and the use of soybeans for hay and green manure.

A pig club was again organized in Morris County this spring with 32 members and over two hundred boys and girls registered in garden work this summer. A judging team of three boys was selected to judge vegetables at the Trenton Fair this fall. Out of this team, one boy was chosen as the captain of the state team to go to the Eastern States Exposition at Springfield, Mass.

During the summer a two-day vetch campaign was conducted in the county with the help of Mr. J. B. R. Dickey, extension specialist in soil fertility. As a result, 9 farmers have sown 81 acres for seed purposes.

The Farm Service League of Morristown, which was organized this spring, enlisted over 600 men, women, boys and girls for emergency farm labor during the past summer. Of this number 149

persons have been placed in permanent positions on farms. A canning kitchen also was operated under the direction of the league. This made possible the conservation of large quantities of fruits and vegetables.

Ocean County

L. A. Cooley, County Superintendent

Ocean County was organized for farm demonstration in May, 1917, and L. A. Cooley was appointed superintendent of farm demonstration May 21. The local supervision of the work was put under the direction of the Ocean County Board of Agriculture. The community plan of organization was adopted and the following executive committee was appointed: James D. Holman, Chas. N. Warner, Chas. A. Morris, Hon. David Conrad, John Bahr, J. R. McFarland, Chas. S. Greene, Anton Clement, and D. W. Reid. Seven communities in the county have organized their community committees under this plan. The first annual picnic of the Ocean County Board of Agriculture, held on August 31, was attended by 400 people and did much toward helping the organization of the work throughout the county.

The project work includes alfalfa planting, field selection of seed corn, the use of cover crops, potato seed selection from immature plants, emergency rye planting, poultry culling, and soil improvement. Eighty-six cooperators have planted rye and vetch as a cover crop on 742 acres. Besides definite project work that has been started, considerable time has been given to the answering of miscellaneous inquiries. Assistance has been given to 101 persons; who have made inquiries concerning 35 different subjects. A large percentage of this assistance has been successful.

Passaic County

Ellwood Chase, County Superintendent

At the joint meeting of the advisory committee of the office of farm demonstration and the directors of the Passaic County Board of Agriculture, the plan of combining the two organizations was approved. This plan was adopted at the annual meeting of the county board of agriculture in December and a constitution and by-laws providing for placing the county board on the community basis was approved. Seven communities were selected for organization, all

of which have since formed community committees. The following executive committee has had local supervision of the work: D. Henniger, *ex-officio*, G. L. Fisher, C. Fred Day, A. Laauwe, Wm. Ellis, Alfred Vreeland, and Mr. Rose. Demonstration work has been carried on with alfalfa, poultry, dairy, potatoes, soil improvement, orchard, cauliflower growing and cost accounts.

One orchard management demonstration has been conducted during the past season with the following results: total cost of spraying, cultivation and labor, $75.61; receipts from the sale of 170 baskets of peaches, $148.97; leaving a profit of $73.36.

Seventeen market gardeners planted Long Island Dwarf Erfurt Cauliflower this year. Results indicate that these strains are not adapted to the production of early cauliflower. However, four co-operators tried this strain of seed on the late out-door crop and report that the crop did well and is equal to other strains of cauliflower.

Six boys' and girls' clubs were organized in the county last year, and have been frequently visited by the county superintendent.

Through the efforts of the community committee at North Haledon, the North Haledon Farmers' Exchange, a $25,000 capital stock corporation for the buying of farm supplies, was organized with a paid-in capital of $3,700. This organization has 91 stockholders in the Borough of North Haledon, showing that these men have learned the necessity and value of cooperation.

Salem County

Walter C. Vail, Emergency Agent

During October Salem County was organized for emergency farm demonstration work. Local supervision is in the hands of the following committee of representative farmers: Clifford L. Crispen, D. S. Craven, Wm. Hackett, John P. Ridgeway, Henry M. Loveland, F. Gilbert Borton, J. M. Wolman, A. V. Waddington, Raymond Lipman, Chas. R. Hires, and Harry Kandle.

Somerset County

H. C. Haines, Emergency County Agent

Somerset County was organized for emergency farm demonstration work in September, and H. C. Haines was appointed emergency

county agent to take up his duties September 10. The local direction of the work was placed under the Somerset County Board of Agriculture, the officers of which are acting as an emergency farm demonstration committee.

As the dairy interest is large in Somerset County, the members of the county board felt that work toward the promotion of a dairy record association would be of value. Since the Middlesex-Somerset Dairy Record Association had been organized in January, and since there was still room for a few members, Mr. Haines, with the assistance of John W. Bartlett, extension specialist in dairy husbandry, immediately took up the work of securing additional members for this association. To date 7 dairymen have joined.

The local committees have been called together and assistance has been given in planning for three farmers' institutes in the county this winter.

Sussex County

Paul B. Bennetch, County Superintendent

The Sussex County Board of Agriculture was reorganized on the community plan in January; and has taken over the local supervision of the work of the office of farm demonstration. Sussex County was the first in the state to adopt the plan of electing community committees instead of appointing them. The work in the county this year has been along the lines of dairy improvement, alfalfa seeding, poultry raising, orchard management, soil improvement, and corn variety tests.

The Walkill Valley Cow Testing Association and the Sussex County Cow Testing Association have continued their record keeping work during the year. The Walkill Valley association is on its third year of work, and the Sussex County association started its fifth year on October 1. Records are being kept of over 1100 cows by these associations. The use of the home-mixed calf meal has been followed with good success.

During the summer the feed situation became so serious that the county board of agriculture felt it desirable to hold conferences with the feed dealers of the county to determine advice to give in the purchase of concentrates. As a result of these conferences, it was thought best to advise the purchase of oil meal, which was then selling for $45 a ton. As a result, one dealer has already sold 22 carloads, compared with a total of 13 carloads sold last year. Another

dealer, who last year had found it impossible to sell one carload of oil meal, sold 9 carloads this year.

The executive committee advised the seeding of alfalfa with clover and timothy in oats, wheat, or rye, especially on well-drained land that had received applications of lime. This method of seeding was recommended at the community meetings held, and as a result 98 men seeded alfalfa in this way. A number of these have been visited and good fields of alfalfa with clover and timothy have been found. In addition to this, 3 sets of test plots and 12 fields of alfalfa were seeded this fall and 2 old fields were renovated by reseeding this summer.

An effort was made in the spring to get a large number of men to use acid phosphate to reinforce barnyard manure. As a result, 32 men agreed to follow this recommendation, and to leave a check strip in the corn or oats. From present indications, this has given excellent results. One test of silage corn was conducted with 13 different lots of seed, the yield varying from 10.5 to 18.9 tons per acre.

At the request of the Sussex County Fruit Growers' Association, Mr. W. A. Houston was placed in charge of all fruit work during the summer. Mr. Houston has concentrated his efforts largely on the improvement of Sussex County apples, and particularly has made an effort to get the growers interested in cooperative marketing, carrying out the plans of the Bureau of Markets of the State Department of Agriculture. A number of growers have agreed to pack and crate their apples this fall according to a uniform plan. They have also adopted a brand name for fruit, under which it will be sold on the market. Orchards used for demonstrations this year show considerable improvement, because better orchard practices and more summer sprays were used.

One February hatching demonstration was conducted and pullets hatched in this way started to lay July 8. Four culling demonstrations were conducted during September. In addition to these, a total of 1155 hens were culled in three different flocks since the demonstration.

In cooperation with the county superintendent of schools, 69 boys' and girls' home gardens were visited during the month of July.

Throughout the year the office of farm demonstration has acted as a clearing house for information concerning activities of the Dairymen's League of Sussex County. Assistance has also been rendered in attending the local and county meetings of the league.

REPORT OF THE EXTENSION SPECIALISTS IN FRUIT GROWING

ARTHUR J. FARLEY

The extension work in horticulture during the past year has been greatly disturbed by the unusual conditions brought about by the war. Frequent and sudden changes in the office of extension specialist have seriously interfered with the effective development of the project work outlined at the beginning of the year. Mr. L. G. Gillam resigned as extension specialist to enter business on April 1, 1917, at which time his work was taken up by Mr. Julian F. Miller. Mr. Miller having offered his services to the military department was soon called to the officers' training camp at Fort Myer, Va., but was later released to assist in the horticultural extension work. On June 1, Professor Arthur J. Farley of the horticultural department of the College and Experiment Station took general charge of the work as acting specialist in fruit growing, continuing in that capacity until the end of the season. Mr. Gillam returned to agricultural work on June 1 as a special assistant in the State Bureau of Markets, in which capacity he devoted his time to special instruction work in the harvesting, packing and marketing of peaches under the direct supervision of the acting extension specialist. Mr. Gillam was assisted in this work by Mr. Willis P. Duruz, also acting as an assistant in the State Bureau of Markets. Mr. Gillam was again appointed extension specialist on September 1 to fill the vacancy caused by the resignation of Mr. Miller to enter the military service as a member of the aviation corps. Mr. Gillam then served as extension specialist until October 15, when he also resigned to enter the navy as a member of the paymaster's department. During the entire year up until September 1, Mr. Harry C. Haines has continued his work as assistant extension specialist, resigning on the above date to accept the position of farm demonstrator in Somerset County. The report submitted by Mr. Gillam and appended herewith includes in a general way the work done by Mr. Haines.

REPORT OF L. G. GILLAM

The work of the past year has consisted in carrying on fruit projects throughout the state, personal visits to farms, judging

exhibits at fruit shows and giving talks and demonstrations at farmers' institutes and fruit meetings.

The following projects have been carried on in the different counties: apple and peach orchard management, substitute summer spray for peaches, fruit survey work, top-working of apples and peaches and spraying of peaches and apples for the production of perfect fruit. Demonstrations also have been conducted to show the proper methods of pruning, spraying, harvesting, packing and marketing of peaches and apples.

Orchard Management Demonstration

The object of this project has been to demonstrate the best methods of management in peach and apple orchards throughout the state. A total of 70 orchards were selected in the various counties, and with the cooperation of the county demonstrators and orchard owners, several were conducted according to the methods recommended by the horticultural department under the above-named project.

Just as considerable time was spent in Sussex and Bergen counties last year, so has much attention been given to orchards in Morris, Burlington, and Cumberland counties during the past year. An effort has been made to concentrate on these counties, in order to carry out the orchard management project with the best results.

The apple orchard owned by Mr. Hugh M. Babbitt in Morris County is one of the finest demonstrations in the state. This orchard consists of 75 trees, 18 years of age, and mainly of the Baldwin variety. These trees were pruned and sprayed by Mr. Babbitt, assisted and directed by the Morris County farm demonstrator and extension specialists. An examination of this orchard on October 10 showed the fruit to be free from codling moth and aphis injury. This is of particular interest in view of the fact that aphis injury was very common in many orchards in the state this year. The trees are well laden with fruit, and many of them will yield as high as 8 barrels per tree. In that section of the state, where high-class fruit is at a premium, Mr. Babbitt's orchard stands out prominently, and his trees will produce fruit far superior to any in the neighborhood. An orchard of this type in a section like Morris County should be a great incentive to fruit growers, and too much praise cannot be given Mr. Bab-

bitt for his hearty cooperation and his willingness to carry out the methods as outlined in the orchard management project.

In Passaic County, excellent results have been obtained in the apple and peach orchards of Mr. A. Koch, of North Haledon. These orchards, when first visited by the Passaic County demonstrator, Mr. Chase, were in bad shape, showing no income. Mr. Koch agreed to carry out the methods as given in the orchard management project, and has obtained excellent results.

In Burlington County, Mr. Reid, the farm demonstrator, has conducted 4 demonstration peach orchards, with excellent results. The orchards referred to are owned by Harry Hutchinson, Jobstown; Merritt Smith, Mount Holly; Budd Jones, Vincentown, and Arthur J. Collins, Moorestown. These orchards were pruned, sprayed, cultivated and fertilized according to methods prescribed and demonstrated by Mr. Reid and the extension specialists. Special attention was given to the proper packing of the fruit from these orchards, thereby increasing the market value of the fruit, and the actual net profit from the crop.

Mr. W. W. Oley in Cumberland County has cooperated with 5 orchard owners in his county, and secured fine results. Records of all expenses and receipts have been kept in these orchards, and these records, together with those from other demonstration orchards, will be compiled and filed shortly.

Many other orchards have been managed according to the principles recommended by the horticultural department, and considerable improvement in apple and peach orchards over the state has been brought about by the use of these model orchards placed in sections where fruit growing is, or should be, an important industry.

Substitute Summer Spray for Peaches

The new summer spray for peaches tried out last year as a substitute for self-boiled lime-sulfur, and consisting of a mixture of sulfur, hydrated lime and glue, has been successfully used in many orchards this year. Twenty owners of peach orchards have cooperated in testing this new mixture during the past season, and where the mixture was properly prepared excellent results have been obtained.

In the orchard of H. W. Leeds at Westville, three applications of hydrated lime, sulfur and glue mixture to a block of Elbertas

gave as good control by actual counts as did a similar block sprayed an equal number of times with self-boiled lime-sulfur. In this orchard the advantage was slightly in favor of the glue mixture. A similar test was conducted in the orchard of F. Wood Wyne, at Thorofare, on a block of Champion, in which counts made at picking time show the following results:

Treatment	Fruits Free from Scab	Fruits Affected by Scab
Self-boiled lime-sulfur.........	653	18
Hydrated lime, sulfur and glue.	539	13
Check	138	588

It can be seen from these results that both the self-boled lime-sulfur and the new mixture were almost equally effective in controlling scab on a variety very susceptible to this fungous disease. In Burlington County, the value of the hydrated lime, sulfur and glue mixture was demonstrated in the orchards of Harry Hutchinson, Jobstown; Merritt Smith, Mount Holly; and Budd Jones, Vincentown. Excellent commercial results were obtained in these orchards, while the counts made in the Jones orchard show the new mixture to have a slight advantage over the self-boiled lime-sulfur in the control of scab. Five ⅝-bushel baskets of fruit were picked from each block, from which the following counts were secured:

	Self-Boiled Lime-Sulfur			Glue Mixture		
Basket	Clean	Slightly Scabby	Badly Scabby	Clean	Slightly Scabby	Badly Scabby
1	115	14	9	114	33	25
2	148	9	11	103	21	30
3	145	8	8	134	13	11
4	70	44	36	121	12	18
5	104	12	23	145	9	6
Total	582	87	87	617	88	89

The above records, in addition to results secured in many other orchards during the past season, show conclusively that both the glue mixture and self-boiled lime-sulfur will give sat-factory control of peach scab. This does not mean that the hydrated lime, sulfur and glue mixture will ever entirely take the place of self-boiled lime-sulfur as a summer spray for peaches, but in view of experience gained and results secured during the past two seasons, it is to be strongly recommended

under the following conditions: (1) where it is difficult to secure the proper kind of stone lime for use in preparing self-boiled lime-sulfur; (2) where orchardists have had difficulty in preparing or applying self-boiled lime-sulfur; (3) where less than 200 gallons of the mixture is used at each application, thus making it difficult to keep an ample supply of stone lime on hand; (4) where a summer spray on peaches has never been used, and it is not desirable to prepare self-boiled lime-sulfur or buy a commercial preparation; (5) where it is necessary to make an application within less than a month of the ripening period. Full directions for preparing and using this mixture can be found in Circular 63 of the New Jersey Agricultural Experiment Station.

Dusting Peaches

Experiments conducted in the peach orchard of Mr. Howard F. De Cou, near Haddonfield, by the horticultural department of the Experiment Station in cooperation with the extension specialists, clearly indicate that the dusting of peaches with a combination of finely-divided dry lime and sulfur will control peach scab equally as well as self-boiled lime-sulfur or the hydrated lime, sulfur and glue mixture. This is a proposition that should appeal to every large commercial peach grower on account of the great saving in time and labor. It is interesting to note in connection with these experiments that 100 six-year old trees were dusted in less than 30 minutes, while over an hour was required to cover the same number of trees thoroughly with a wet spray. It is also an interesting fact that the fruit on the dusted plots was somewhat brighter in color than fruit sprayed with self-boiled lime-sulfur. This method of controlling scab and brown rot is recommended to all peach growers whose orchard interests are large enough to warrant the purchase of a power duster. The experiments this year prove beyond a doubt that dusting is efficient as a means of controlling peach scab. It therefore remains only for each grower to decide whether dusting is more or less expensive than spraying under the existing conditions, taking into consideration cost of labor, materials, and machinery.

Demonstrations of thorough spraying methods were conducted in several orchards in Cumberland County with good results. In these orchards, blocks of trees were selected which were

sprayed regularly throughout the season by extension men co-operating with Mr. W. W. Oley, the Cumberland County demonstrator. At the conclusion of the season, it was clearly shown by the results obtained that thoroughness in spraying is one of the main requisites in the control of peach scab.

Fruit Survey Work

During the past winter a survey was made of the peach growers within a radius of 5 miles of Vineland. This section is one of the largest peach-growing districts in the state, and the results of such a survey will be valuable. One hundred and fifteen farms were visited and a total of about 200,000 trees will be included when the survey is finished. Besides securing the number of trees, the age, variety and condition of all orchards visited were obtained. These data will give valuable information as to the popularity of varieties, number and age of orchards, and other statistics which can be used in marketing the immense peach crop from this area.

Marketing of Peaches

Considerable work was done during the past season by the State Bureau of Markets, assisted by the extension division, in aiding peach growers to pack and market their crop properly.

Circulars and placards showing the different styles of pack, together with proper directions for packing, marking and shipping peaches were distributed to peach growers over the state. Packing schools were held during the month of July to train high school students and farm help as expert peach packers. As it was impossible to obtain peaches for this work at such an early date, wooden balls of different sizes were used and proved ideal substitutes. Packing schools were held in Cumberland, Gloucester, Burlington, Atlantic and Mercer counties, and were well attended. Many packers were trained, whose experience proved valuable at the height of the season. As the early varieties began to ripen in South Jersey, Mr. W. P. Duruz was placed in Cumberland and Gloucester counties, and means provided for transportation to orchards in the county. Likewise, Mr. L. G. Gillam was placed in Burlington County to assist the growers in the marketing work. In this way, many growers were reached and standard packs adopted. New Jersey peaches coming into

the large eastern markets during the past season showed a marked improvement in the method of packing and shipping.

Summary

The work accomplished by the extension men in horticulture during the past year may be summarized as follows: Meetings held, 95, with a total attendance of about 3100; farms visited, 750; letters written, 950; and fruit judged at 6 fairs and farmers' picnics; the above in addition to numerous visits to demonstration orchards in company with the county demonstrators.

The following projects have been adopted for next year:

Major No. 1. Apple orchard management.
Major No. 2. Peach orchard management.
Minor No. 1. Spraying peaches and apples for the production of clean fruit.
Minor No. 2. Pruning fruit trees.
Minor No. 3. Renovation of old or neglected orchards.
Minor No. 4. Harvesting, packing and marketing peaches.
Minor No. 5. The standardization of peach grades and marks.
Minor No. 6. Thinning peaches and apples.
Minor No. 7. Control of peach borers.
Minor No. 8. Strawberry variety tests.
Minor No. 9. Introduction of seedling peaches.

REPORT OF THE SPECIALIST IN MARKET GARDENING

R. W. DeBaun

Our country demanded a greater production of food products this season as a war measure. Because the growing of vegetables offers the best opportunity to increase production in a short time, there was an unprecedented demand upon the extension division for information on vegetable growing. Most of the demonstration projects carried on are in cooperation with the county agents and the practical commercial vegetable growers; but the home gardeners have demanded far more attention this season than ever before.

During the year just passed the extension specialist delivered addresses on some phase of vegetable growing before 69 meetings with a total attendance of 8476, and wrote 2152 letters. Forty-eight of his articles have been published in the Weekly News Letter, which is sent regularly to the newspapers of the state, and from very early spring until after the middle of summer, "Timely Suggestions on Vegetable Growing" were sent to all the papers in the state each week. These weekly installments, consisting of about 800 words, were published regularly by about 60 papers. The extension bulletin on "The Home Vegetable Garden" has been revised, and over 100,000 copies of it have been sent out by the State Department of Agriculture since March 1, 1917. Probably the project which has demanded the most attention this season has been the home vegetable garden.

Home Vegetable Garden

Home vegetable gardens were planted by the thousands throughout the state, but it was impossible for the extension division to give them personal attention. In many towns and cities, the mayor appointed food commissions to make possible greater production and food conservation. Some of the cities organized commercial production on near-by vacant land for purely patriotic purposes. The work of these organizations was in some cases planned and directed by the specialist for the

extension division. Among those communities, where efforts for food production and its conservation have been closely connected with the extension division may be mentioned: Atlantic City, Caldwell, Camden, Elizabeth, Englewood, Montclair, Morristown, New Brunswick, Perth Amboy, Princeton, Ridgewood and Plainfield. The work done in these towns and in many others in this state is worthy of commendation. It is gratifying to know that the extension division through its county agents and extension specialists has been of definite aid to these philanthropic and patriotic endeavors.

Onion Maggot Control

During the season just passed, considerable attention has been given to the newly developed method for the control of the onion root maggot. The prevention of this pest is by means of the poison bait solution sprinkled around the field. It was tried by a dozen cooperators under the direct supervision of County Agent Oley in Cumberland County. He reports that wherever the material was properly applied very beneficial results were obtained. This poison bait treatment, as prescribed by Dr. Sanders of Wisconsin, was greatly improved in its application by one of Mr. Oley's cooperators, so that it was possible easily to prevent all maggot injury to the onion crop and to the early cabbage, early turnip, and early radishes growing in adjacent fields. A complete description of this new method may be had by writing to any of the county agents or to this office for the project outline on Onion Maggot Prevention.

Disease-Resistant Cabbage

During the last few years, the growing of cabbage has become quite unprofitable, especially in the once popular cabbage districts of Burlington and Camden counties. The reason why the industry has dwindled in this favored section is that the soil has become infected with the dreaded cabbage disease known as "yellows." This same disease threatened to destroy the enormous cabbage-growing industry of Wisconsin, but 6 years of work by their state plant pathologist has resulted in the development of a disease-resistant strain of seed, which can produce heavy

crops even on infected soil. A pound of this seed was procured this spring, and was distributed among 100 commercial growers, who had reason to believe that their soil was infected with this destructive cabbage disease. Many of these growers found that this strain of seed produced well alongside of other which failed. Accordingly, the growers were urged to save the best plants, and grow their own supply of seed the following spring.

Early Tomato Strain Test

The early-tomato growers of Gloucester County, N. J., have developed their methods of handling their plants, and growing their crop to the very highest degree of skill and efficiency. Swedesboro, N. J., is acknowledged to be the heaviest shipping station for early tomatoes in the world. Since this industry is so well established it naturally follows that some of these growers must have a strain of seed far superior in earliness, productiveness or quality to that used by the majority of the growers. Accordingly, samples of tomato seed were collected by the extension specialist from 30 leading early-tomato growers representing nearly as many communities in this country. One sample was secured from Essex County and another from Hunterdon County. The seed was sown in the College Farm greenhouse, and later the plants were "spotted out" on the farm of an excellent grower near Swedesboro. The newly appointed county agent for Gloucester County, Mr. H. F. Huber, thereafter obtained all records of growth, shape of fruit, size, yield and quality. Just before picking began, seventy-five early-tomato growers inspected the field.

Final results showed that the strain of seed used by most of the growers was representative of the Earliana type. This variety is of poor quality, green around the stem, cracks badly, and it quite watery and full of seed. Strange as it may seem, the one sample of seed from Essex County produced more smooth tomatoes than any other lot of seed. The big difference in the various strains of seed was in the different amounts yielded, and this depended upon the constitutional vigor of the strain. Next year these same strains of seed will be tested again, and a dozen or more new strains from other sources will be secured, with the hope that a superior early strain may be found

that will be quite as productive and as early as the Earliana, and at the same time of far better quality. When the quality of the Swedesboro product is improved, the demand for it will be greater.

Cantaloupe Production

The cantaloupe growers who followed the outline of the project on cantaloupe production had excellent results this season. The outline covers the proper preparation of the soil, regarding lime and well balanced plant-food, insect control and blight prevention. Cooperators in Burlington, Bergen, Gloucester and Hunterdon counties were asked which one of the special recommendations they considered of most benefit. Strange as it may seem, the growers were about equally divided in their opinion. However, this simply brings out the difference in soils, cultural methods, insect attacks and diseases peculiar to each section of the state, or even peculiar to different farms in the same community.

Field Bean Production

When a nation is at war, it must have food in a concentrated form and of high food value. Dried beans pound for pound have a higher food value than beefsteak. Therefore, as a war measure, the farmers of this state were urged to plant beans. A circular on "Field Bean Production" was written by the specialist in market gardening for the extension division, and 15,000 of these have been used to advantage. It is estimated that the production of this important war-time food has been increased 50,000 bushels in New Jersey. This is largely a result of the campaign for the planting of this crop carried on by the extension division, with its county agents, by means of lectures and through the cooperation of the press.

Miscellaneous Demonstrations

The enormous sweet potato industry of South Jersey is hampered by diseases of the growing crop and by rot in storage. Eight cooperators in Atlantic County, four in Cumberland and three in Gloucester County are selecting their seed, growing their plants,

rogueing their fields and storing their crop according to the specifications of the project outline of the extension division.

In Gloucester County certain plots in a field of onions grown from seed was sprayed with nicotine sulfate solution to control the onion thrips. The thrips seemed to have been controlled, but there was no increase in the amount of onions produced on the sprayed plots.

Cooperative buying of cauliflower seed in Passaic County resulted in a saving of two-thirds of the usual cost.

The relative value of tar paper discs and tarred sand was demonstrated in Camden, Gloucester and Morris counties. The former gave the best results, but the tarred sand was cheaper, easier to apply and yet efficient.

Cucumber beetle control was demonstrated in the pickle sections of Gloucester County. The mixture of lime and tobacco dust was very effective, and was just as good as a strong arsenate of lead spray.

The county agents have been called upon a great many times for the latest approved methods for the control of cut worms, cabbage worms and the corn ear worm. The popular Golden Self-Blanching variety of celery has proven itself to be very susceptible to leaf blight and to root rot. Meich's Easy Blanching variety is being constantly recommended, and is replacing the former, because of its more vigorous growth, high quality, and disease resistance. This change of variety has materially affected the truck areas and market gardens of northern New Jersey.

The pepper industry of Cumberland and Camden counties is suffering from some form of disease, and Mr. Oley, the county agent, has begun an effort to develop a disease-resistant strain of seed by selecting the most vigorous plants from badly infected fields. This work will be carried on for a few years to see if disease resistance can be developed, with peppers, just as it has been against cotton wilt, cabbage "yellows," celery blight and root rot, and asparagus rust.

A campaign has been carried on to encourage the farmers to save more of their own supply of seed, because of the shortage which seems imminent for next spring. Also the extension division has just issued Bulletin No. 12, "The Winter Storage of

Vegetables in the Home," as a war measure for the conservation of food products.

The larger growers have demanded most of the specialist's time in the past, but with an increased force to do the work, it is hoped that the small growers will get their share of attention. Accordingly, in laying plans for another season it is intended to take up a broader field of work.

Note by the Director of Extension: Charles H. Nissley, who came to the division of extension April 1, 1917, for special work in market gardening, served the state by taking care of State Department of Agriculture correspondence at Trenton during the season. He has returned to the division of extension for project work beginning November first.

REPORT OF THE EXTENSION SPECIALIST IN SOIL FERTILITY AND AGRONOMY

J. R. Dickey

Soil Improvement Demonstration

In the spring of 1916 work was started on 12 one-half acre plots to demonstrate how poor or run-down land could be brought to a state of profitable production without the use of manure or nitrogenous fertilizer. Locations were selected along some main highway in sections where there was much land in an undeveloped or run-down condition similar to that represented by the plot. Most of the plots were situated in the southern part of the state and on soils of a more or less sandy nature. No work was attempted, however, on any of the very poor white sands, the practical value of which, for agricultural purposes, is very questionable.

It is well known that the chief needs of most of these unproductive soils are organic matter, phosphoric acid and lime. The customary method of improvement is to apply city manure liberally, supplementing it with a complete fertilizer and possibly lime. Manure in sufficient amount, however, is very expensive and the supply is limited. It should be much more economical to supply the needed organic matter and nitrogen by growing and plowing under green-manure crops such as cowpeas, rye and vetch, etc. Such crops could be put in with less labor than that involved in carting and spreading the manure. As there is generally more land on the farm than can be cultivated each year, such crops as cowpeas would not interfere with the acreage of money crops. On more intensively farmed land the cropping system can almost always be arranged to include cover crops regularly, and even if one money crop should be sacrificed for the sake of a green-manure crop, the saving in manure needed the next year would make the practice profitable.

Only soils which in their present condition were not considered capable of profitable cultivation were selected. Two plots were on new land which had just been cleared up, while the remainder were on land which had been run down by exhaustive cropping.

Ground limestone was applied at the rate of 2 tons per acre to correct the acidity and promote the growth of the legumes to be grown for soil improvement. Four hundred pounds of acid phosphate per acre was applied and cowpeas were sown about June 1. These made a good growth, considering the impoverished condition of the soil, and were plowed under in September. Rye and winter vetch was sown about October 1. The commercial inoculant used on the vetch proved to be worthless, so that practically no inoculation was secured. This, combined with the lateness of the seeding, due to a very dry fall and the exceedingly dry weather following, caused most of the vetch to die out, leaving only a thin stand of rye as a winter cover crop.

In the past spring it was planned to put all the plots in corn with an application of 400 pounds of acid phosphate. Untreated plots of the same size, adjoining, were to be put in corn to show the producing power of the soil in its original condition. On account of the scarcity of labor there was considerable difficulty in getting the plots properly attended to. On nine plots, however, the original plans were carried through in a fairly satisfactory manner.

In plowing, the furrows on the treated plots stood up firm and coherent and were already somewhat darker in color than those on the untreated. The difference in the corn was early evident. That on the treated portion made a better stand, was a much darker color and rapidly outgrew that on the untreated plots, which was small and yellow.

About August 1 a mixed cover crop of winter vetch and crimson and mammoth clover was sown on the treated plots and cultivated in. The hot, dry weather in early August killed practically all the mammoth clover and much of the crimson. In some cases the vetch was so thin that another seeding of rye and vetch was made after September 1. The dry weather also reduced the corn crop materially on both treated and untreated plots, especially on the more droughty types of soil. The following yields were weighed from measured areas and calculated on the acre basis:

Virgin sandy loam soil with light subsoil, owned by Minch Brothers along the Bridgeton and Millville Pike, Cumberland County; treated portion yielded 18 bushels of shelled corn per acre; untreated portion 11.2 bushels; increase 60 per cent.

Light loamy sand in a run-down field at Centre Grove, belonging to Mr. Howard Spencer; treated portion 18.6 bushels; untreated 8.5 bushels; increase 120 per cent.

Very sandy old field of Mr. A. V. Sutton, Ocean View, Cape May County; treated portion, 33.3 bushels; untreated 16.1 bushels; increase 106 per cent.

Light sandy old field of Mr. J. C. Phillips, Elwood, Atlantic County; treated portion, 34 bushels; untreated 11 bushels; increase 230 per cent.

Sandy loam, old field farmed by Mr. Stephen Hoffman, Franklinville, Gloucester County; treated portion 25.5 bushels; untreated 10.5 bushels; increase 142 per cent.

Run-down sandy loam field of Mr. E. L. Cain, Atco; treated portion, 25.9 bushels; untreated, 15.5 bushels; increase 67.1 per cent.

Virgin fine sandy loam at the Four-Mile Colony, Burlington County; treated portion, 37 bushels; untreated, 22 bushels; increase 68 per cent.

Old field of sandy loam owned by Mr. George Beck, Westwood, Bergen County; treated portion 20 bushels; untreated, 30 bushels; increase 50 per cent.

Fine sandy loam in old orchard near Harmony, Monmouth County; treated portion, 37 bushels; untreated, 21.8 bushels; increase 73 per cent.

The average increase on all the plots was slightly over 100 per cent.

It is very evident that the increase in the corn crop alone has not paid for the treatment given, but it should be remembered that the effect of such treatment will last for a number of years and should show as great increases in the next crop, especially when supplemented by a cover crop in the corn.

Field meetings, in cooperation with the county demonstrator in each case, were held at three of the best plots at the time the corn was husked and weighed. At these meetings methods of soil improvement were discussed.

It is proposed to continue the demonstration on these plots next season, probably by putting the treated portions and at least a part of the untreated, in potatoes or some similar crop, after which the plots will be sown to alfalfa or clover. In most cases

the cornstalks will be plowed under to supply organic matter and potash and only acid phosphate will be used on the potatoes.

Two new plots were started in the fall of 1916 with rye and vetch, and one new one in the spring of 1917 with cowpeas. It is proposed to start more of these plots as time permits and suitable locations present themselves.

Alfalfa Seed Test

In the summer of 1916 the specialist secured samples of alfalfa seed from all the important producing states, and from foreign counties as well, for the purpose of testing their hardiness, productivity and longevity under actual field conditions on different soils and in different parts of the state. The seed was sown in 1-rod square plots in 15 different fields. From the beginning there were marked differences in the characteristics of these plots.

For average conditions, the seed from Kansas so far seems most satisfactory. It survived the winter quite well even in the northern counties and made a large, vigorous growth for every crop during the summer. Nebraska and Utah seed behaved in a somewhat similar manner, but seemed not quite so hardy or productive as the Kansas.

Idaho seed also proved satisfactory. It was quite hardy and produced good crops. Seed from the Dakotas was very hardy and gave heavy crops at the first cutting. The second and third growths, however, were short, especially the last crop.

Texas seed was decidedly injured in the northern counties but did fairly well further south. The growth was vigorous and large. Seed from Arizona wintered worst of all, even in South Jersey. On most plots only a very thin stand survived, though the fall growth was very large and vigorous.

Nevada and Oklahoma seed resembled that from Arizona, and all three should apparently be avoided.

Seed from California gave inferior results, in almost every test, being subject to winter injury.

Turkestan seed and that sold at Russian acted very much alike, and proved very undesirable. Both were quite hardy even in the north and the first crop was good, but later the plants grew very little and were badly affected with blight and leaf spot. The

stand is rapidly thinning out and the remainder will probably die in the second winter.

South American seed was not hardy and cannot be recommended, though the growth was vigorous.

Five of the hardy strains, such as Grim and Baltic, were tested. They all proved hardy and the first crop was heavy on account of the thick stand. Later crops, however, especially the third, were lighter and the growth notably shorter and less vigorous than the plots of Kansas, Idaho and southern seed. These very hardy strains and common alfalfa from far northern sources seem to be stunted by our hot summers, and while they may be advisable under certain circumstances in the northern counties, their general use cannot be recommended. Seed from Kansas and states north of Kansas so far appears most satisfactory.

These test plots aroused so much interest that a more extensive series was arranged and started during the past summer directly under the supervision of the Experiment Station and the State Alfalfa Association.

Maps of State Institution Farms

At the request of the state specialist in farm management, the work of making maps of all the state institution farms was undertaken. Of many of these farms there was not even an outline map, and of none was there an accurate field map.

To date the following farms have been mapped and tracings and blue prints made: State Home for Boys at Jamesburg, Manual and Industrial School at Bordentown, State Sanatorium, Glen Gardner, and the Women's Reformatory, Clinton. On these maps all the field boundaries, buildings, roads, fence rows, streams, drains, woods and waste land have been shown, and the acreage of each field computed. Where important soil differences, such as deficient drainage, etc., occur, they have been indicated. The maps were made on a uniform scale of 500 feet to the inch, and should be of service in computing the acreage of the various crops, reorganizing the lay-out of the fields to better advantage, planning the future cropping system, etc. The remainder of the state farms will be mapped as time permits.

Farm Drainage Work

Several requests for advice and assistance on the practicability and lay-out of farm drainage systems have been responded to by the specialist, generally in cooperation with the county demonstrators. Under the supervision of Mr. John R. Haswell, of the United States Office of Public Roads and Rural Engineering, a complete system of tile underdrains was surveyed and laid out on a 20-acre field belonging to Mr. Edward S. Winsor of Farmingdale, Monmouth County. Over 6000 feet of ditch was dug here with a Buckeye ditching machine and the tile installed under extraordinary difficulties on account of quicksand, etc. The system is giving good satisfaction and the present crop of corn on the land is excellent. Another smaller system of tile was surveyed and laid out in Passaic County, and has given excellent satisfaction during the past summer.

On several other farms, levels have been run to determine whether there was sufficient fall to install a system and advice given as to its lay-out. The specialist cannot be expected to undertake the detailed survey of extensive drainage projects on which the services of a competent engineer should be secured. There is much poorly drained land in the state which should be improved, and many wet spots which should not be allowed to interfere with the cultivation of the remainder of the field at the proper time.

Emergency Work

Considerable time has been devoted to giving assistance to the demonstrators installed in newly organized counties. This was especially the case in Ocean County. Frequent visits were made and days spent with the other demonstrators for the purpose of keeping in touch with the agronomy work being carried on by them and to give suggestions and advice on questions of soils, crops and farm management. The specialist cooperated in a 2-day campaign to promote the growing of vetch in Morris County, and prepared an exhibit of soils and soil improvement methods for the farmers' picnic in Ocean County.

Frequent requests were received for advisory visits to farms in unorganized counties, especially from parties who had just

bought land and desired advice on questions of crop adaptation, fertilizers, etc. Where the area in question was of sufficient size to warrant the trip and where time permitted these requests were complied with.

A 30-page circular was prepared covering fully the improvement of the poor soils and run-down soils of the state along the lines followed on the soil improvement plots. A poster giving the reasons for sowing cover crops and general advice and suggestions on the subject was issued during the summer and was accompanied by a supplementary circular. A similar poster and circular dealing with the common wastes of farm manure and their prevention were prepared and issued later.

Numerous articles were prepared for the weekly news letter on subjects which seemed of timely importance, and suggestions were sometimes offered the county men on the publication in their news letters of similar material.

Corn Tests

Some extensive and carefully planned work in testing out local strains of corn was undertaken during the past year and some excellent and conclusive results are confidently expected. This work was conducted by the assistant specialist, Mr. A. G. Waller, whose report follows.

REPORT OF THE ASSISTANT EXTENSION SPECIALIST IN AGRONOMY

ALLEN G. WALLER

CORN COMMUNITY DEMONSTRATIONS

The project of the corn community demonstration has been continued this year on a more extensive scale and with the definite purpose of determining the most productive local strains of corn for particular communities or counties.

The method consisted in collecting samples of seed corn from a number of farmers in each locality and securing five cooperators to plant two rows of each across their own corn fields. When mature the yield from one-twentieth of an acre of each strain was weighed and a field meeting held at which the results from the five farms were compared and discussed. On each farm at least 10 pounds of each strain of corn was laid aside to be weighed and shelled when thoroughly dried to obtain the shrinkage and actual yield of shelled corn. The field weights do not make allowance for any difference in maturity and moisture content, nor for the shelling percentage which will vary considerably. The value of this in accurately ranking the yielding power of the different strains was clearly shown in the two instances where tried last year. At the demonstration on J. Herbert Brown's farm, the shrinkage from fall to spring varied from 4.3 per cent to 15.7 per cent, with the different strains, while the shelling percentage ranged from 79.4 to 84.9 per cent. In the same way at L. C. Mackey's farm near Belvidere, the shrinkage varied from 19 to 41 per cent, and the shelling percentage from 80.6 to 87.8 per cent.

These differences between corn strains are very marked and must be considered in obtaining their relative yielding powers. The corn at Mackey's that shrank 41 per cent was third in yield when weighed in the field, but when dried out became fifteenth or almost the lowest.

These corn test demonstrations have been carried on by the writer in 7 communities on 31 farms located as follows: 5 in Salem County, 5 in Gloucester, 5 in Camden, 10 in Hunterdon, and 6 in Warren. The number of samples in any one demonstration ran from 8 in Warren County to 17 in Salem County. The

lowest variation on any one farm was 13 bushels per acre, which was obtained on a farm in Warren County, where the yields ranged from 28 to 41 bushels per acre. The largest variation was 40 bushels per acre, also obtained in Warren County on a farm with yields ranging from 60 to 100 bushels per acre. The percentage difference in yield of the highest over lowest ranged from 24 per cent in Gloucester to 122 per cent in Hunterdon.

It has been quite clearly demonstrated this year that in most communities there appear to be a certain few strains of corn that will consistently out-yield the others grown in that locality. The results from the five farms in the same community showed in nearly all cases the same corn strains giving the highest yields. Two other facts were demonstrated this year that tended to prove it possible to eliminate many poor-yielding strains and obtain for a community higher average corn yields by growing and inproving the better strains.

1. In three communities, Belvidere, Sergeantsville and Swedesboro, the corn strains that ranked as best yielders last year when tried on but one farm, held the same relative rank this year when tried on five farms.

2. It seemed to make no appreciable difference whether the strains were in a low-yielding or a high-yielding corn field, as the comparative ranks remained about the same. For instance, at Belvidere, on a field where the average yield of all strains was but 34 bushels per acre, the strains had practically the same rank as on a field where the average yield was 83 bushels per acre. Then again at Sergeantsville the same strains were leaders where the average yield was 41 bushels and where the average yield was 64 bushels.

This project is impressing the farmers in the communities where tried with the idea that certain strains of native corn can be obtained that wonld increase the average yield of a community if grown more largely in place of the strains that have been demonstrated to be poor yielders. Repeating the project in these communities again on five farms would demonstrate still more clearly the best varieties or strains for local conditions, and would allow for seasonal variations as well as individual farm variations.

In several instances the leading farmers of the community have recognized it as a business proposition and have volunteered to carry on the work.

Another indication that this project has aroused interest is the fact that the average attendance at the field meetings has been 40.

Farm Management Work

Farm Surveys

1. The data from the survey of 47 farms in Sandystone and Montague townships in Sussex County were tabulated; and the most profitable type of farming and the best organization for these farms were determined. These results were published in the Annual Report from the Sussex County Farm Bureau for 1916.

2. At the request of the Mercer County Farm Bureau and with the cooperation of the Pennington branch of the Inter-State Milk Producers' Association, 44 farm records were taken in the Pennington area. This section is a dairy and general farming area. The survey was taken to determine the important factors governing profits and losses in the farm business and the best organization of the farm business for profits in this area. The data from the survey have been tabulated and are in the printer's hands to be returned to the farmers as a farm bureau circular.

Cost Accounts

Seven farm account books were collected and the data summarized in shape to be returned to the farmers, including cost of production, distribution of labor and profits, as well as a study of each individual farm organization. These farmers all have potato farms and for the season of 1916 produced 181 acres of potatoes at an average cost of $87.68 per acre, with an average yield of 250 bushels per acre, while they were producing 98 acres of corn at an average cost of $37.93 per acre.

Considerable time was spent on working out a model account for the farm-accounts publication which is about to be published.

Several individual farmers at their request have been aided in figuring out costs on their farms.

REPORT OF THE EXTENSION SPECIALIST IN *POULTRY HUSBANDRY*

VICTOR G. AUBRY

The project work in poultry husbandry as outlined in last year's report has been very satisfactory, even though the records on a great many of the major projects will not be complete until a month after this is written. From the experience of the last two years on the keeping of records of projects, it has been found that nearly all of the cooperators start the records in good faith but that a large number never completed them. This is not necessarily because they were too complicated or because it took so long to fill them out, as was at first thought, but because often they were not kept up to date, and the farther they fell behind, the harder they were to keep. Consequently, many cooperators naturally dropped out sooner or later. For this reason, the records which were not reported fully in the past year will be somewhat revised along the lines of monthly reports to be filed regularly. It is hoped that many who fail to complete this year's records will find the new system easier and more satisfactory.

DETAILED REPORTS OF PROJECTS*

Major Projects, 1-2, Educational Demonstration Projects

Thirty-four caponizing demonstrations were given in 14 different counties, with an attendance of 361 people; 106 persons were taught by actually operating on from one to ten birds, under the supervision of the extension specialist. In one case, one of the men present operated on 24 of his birds during the demonstration. The increased demand for these caponizing demonstrations comes from the excellent results obtained in the work last year, as a great many people found it quite profitable to hold the birds they had been selling as roosters at a very low price, and sell them as capons in the latter part of the winter, at an extremely fancy price, ranging from 38 to 50 cents a pound. Only 4

*A detailed outline and explanation of all projects listed in this report may be found in the report of the extension specialist in poultry husbandry in Extension Bulletin 10 of the New Jersey Agricultural College.

demonstrations in killing and picking were given this year, as the extension specialist found that practically all over the state farmers and poultrymen could dispose of their stock as live poultry, at nearly as good a figure as could be had for well-dressed birds. Eighteen demonstrations were given in testing incubator eggs on both these tests as a guide to determine the amount of moisture needed in artificial incubation. At seven of these demonstrations eggs in an incubator were compared with eggs under a hen at the same period of incubation, and at 12 demonstrations, instruction was given in candling and grading eggs for market.

This year a special effort was made and a great deal of time spent in the culling of non-producing birds, and the selection of breeding stock to be held over. From August 15 to October 1 practically all of the specialist's time was devoted to this work. During this campaign 20 counties were covered and 81 demonstrations given. Previous to the campaign 18 demonstrations on culling were conducted. Records were kept on the egg production for 7 days previous to the demonstration, and for 7 days after the demonstration. A record of the total number of birds was kept, and also of the number of birds to be marketed. A summary of the records is as follows: 18 culling demonstrations were given after May 1 and previous to August 15, at which 117 people were present; 2300 birds were gone over, and 650 culls taken out to be sold; the 2300 birds laid 8400 eggs during the 7 days previous to the demonstration, and 8270 eggs in the 7 days after the demonstration.

The report of the culling demonstration* given from August 15 to October 1 is as follows:

Total number of demonstrations	81
Number of persons present	1,762
Number of birds gone over	22,542
Number of birds culled out	10,668
Number of culls to be kept for a short while	3,256
Number of demonstrations per week	13.5
Average number of persons per demonstration	21.1
Average number of birds per demonstration	128—
Per cent of profitable birds	52+
Per cent of birds to be disposed of	48—

*In these demonstrations, Prof. H. R. Lewis, professor of poultry husbandry, covered Ocean and Cumberland counties.

Because of the early date of writing this report, the egg production of the birds for 7 days following the demonstrations has not been obtained in all cases. The production on but 7,532 birds before and after the demonstrations was as follows: for the 7 days previous to the demonstration—17,565 eggs, or practically 33 per cent; for the 7 days following the demonstration 17,205 eggs, a production of 32 per cent on the basis of the total number of birds. This is a drop of less than 1 per cent, while the number of birds culled out was 47 per cent, cutting the feed prices down practically to one-half. There is every reason to believe that the records of egg production of the other 15,000 birds will show a very similar percentage. Special emphasis was placed upon this demonstration because of the scarcity of poultry feeds and the present need of economy. The results were so gratifying that this plan of demonstration will be conducted as a permanent practice at least for a few years to come.

The following methods were observed in carrying on these demonstrations. Three or four specimens showing the points to be used as a basis of selection of the good and poor birds were taken from the flock and a short talk given, these specimens being used as illustrations. After this, the demonstrator would go over about fifty birds, placing them in the different groups. The people present were then asked to go over the balance of the birds, placing them in these various groups after the demonstrator had inspected them. In this way, most of those present were able, at the close of the demonstration, to select the birds for the various groups with very good accuracy. One man, after having been at a demonstration, culled 411 of his own flock; and two weeks later, the demonstrator, after going over this flock again, found only 4 birds that he would have placed differently.

At 32 demonstrations given above, special pens made for cockerel breeding were selected. These pens in each case consisted of from 10 to 12 of the very best birds in the whole flock, to be set aside at the next breeding season, and the male progeny from this special pen to be used as breeding males the following year.

Major Project 2—Local Poultry Associations

No new local poultry associations were formed this year; but the extension specialist visited most of the old local associations,

and instituted a system whereby breakage claims in transportation could be more easily realized. It was found that a tremendous lot of eggs were both lost and broken in transit during the past year, and that very few of the claims filed by the association were collected. This condition demonstrated the necessity of a new system of filing breakage claims.

Major Project 3—Chick-Raising Contests

Chick-raising contests among the boys and girls of Ocean County were organized again this year. They have since been turned over to the new state leader of boys' and girls' agricultural clubs.

Major Project 4—Record Keeping

This project was started last year in 14 counties with a total of 74 cooperators. The records kept in this project are not due until a later date.

Twenty-two of the seventy-four who started this project reported during the month of August that the records were kept to date, and it is expected that practically all of these will complete their records this year. Many of these projects were dropped because it was found that more were started than could be handled satisfactorily, and most of the county agents found it impossible to follow them up as planned, because of the additional work brought about by special emergencies. As was previously referred to, the old style of records in these projects will be revised, and monthly reports made.

Major Project 5—Cost of Hatching Chicks

Thirty-two cooperators conducted this demonstration project, and 26 complete sets of records were obtained. This project was varied somewhat from the outline given in the 1916 report, including March, April and May-hatched chicks. It was found that ascertaining the cost of hatching and brooding was very interesting and valuable to the men conducting the project, as most of them had no idea of the cost of these operations.

The following summary is given of the average costs taken from the records which have been completed, as space will not allow the printing of these records in detail.

Total number of demonstrations	26
February.	
Number of demonstrations	5
Total number of eggs set	1435
Total cost of eggs set	$63.05
Total number of chicks hatched	718
Number of infertile eggs	196
Per cent infertile	12.54
Total number dead	520
Per cent of fertile eggs hatched	50.72
Total cost of all chicks hatched	$76.52
Average cost per chick	$0.1066
March.	
Number of demonstrations	4
Total number of eggs set	1246
Total cost of eggs set	$57.20
Total number of chicks hatched	492
Number of infertile eggs	180
Per cent infertile	14.40
Total number dead	641
Per cent of fertile eggs hatched	46.00
Total cost of all chicks hatched	$64.78
Average cost per chick	$0.132
April.	
Number of demonstrations	9
Total number of eggs set	4832
Total cost of eggs set	$188.54
Total number of chicks hatched	2449
Number of infertile eggs	262
Per cent infertile	5.40
Total number dead	2121
Per cent of fertile eggs hatched	53.00
Total cost of all chicks hatched	$223.26
Average cost per chick	$0.091
May.	
Number of demonstrations	8
Total number of eggs set	2448
Total cost of eggs set	$65.98
Total number of chicks hatched	1528
Number of infertile eggs	247
Per cent infertile	10.00
Total number dead	1191
Per cent of fertile eggs hatched	69.40
Total cost of all chicks hatched	$88.90
Average cost per chick	$0.058
Total hatching records of 26 demonstrations.	
Total number of eggs set	9961
Total cost of eggs set	$347.77
Total number of chicks hatched	5187
Number of infertile eggs	885
Per cent of infertile eggs	11.25
Total number dead	4473
Total cost of all chicks hatched	$453.46
Average cost per chick	$0.081

The following are the records obtained, giving the cost of raising a February-hatched pullet to four months of age:

Total number of chicks at start of demonstration	1708
Average cost of February chick	$0.1066
Total cost of chicks at start	$182.07
Number of chicks dead	228
Number of cockerels sold as broilers	698
Number of pullets at the completion of demonstration	681
Returns for cockerels sold	$247.07
Total cost of labor at 20 cents an hour	$59.40
Total cost of feed and fuel	$418.50
Total expense for chicks, feed, fuel and labor	$659.97
Net cost of flock left	$414.90
Net cost per pullet	$0.61

An effort will be made to conduct Major Project 4 with the pullets hatched in the different months under this project.

Major Project 6—Pedigree Breeding

Two demonstrations were completed under this project, one in Warren County and one in Camden County. Some very favorable results were obtained. In one case during the hatching season last spring, every one of 38 eggs saved from one particular hen was hatched.

Minor Project 1—Poultry House Construction

Eighty-eight multiple unit houses were constructed according to the plans and blue-prints furnished by the extension specialist, 16 of which houses were built outside the state. Also, 144 old poultry houses and farm buildings were remodeled along the principles of poultry house construction, as advocated by the poultry department, making a total of 232 poultry houses built under this project. The keeping of cost records was not very successful in this project, because of the great variation of prices in different sections.

Minor Project 3—Feeding Sour Skim Milk

Only one demonstration under this project was conducted, as it was found that the cost of skimmed milk in most places was at least four cents a quart.

Minor Project 5—Feeding Meat Scrap

In a number of sections of the state it was impossible for poultrymen and farmers to obtain meat scrap, and consequently many flocks were fed without this ingredient, resulting in a very marked decrease in egg production.

Minor Project 8—Skim-Milk Substitutes

In the sections where this project was conducted last year, a large quantity of similar products was used again this year, especially the milk powder and Eg-O-Milk Albumen. These products also increased very materially in price, and semi-solid skimmed milk, and especially semi-solid buttermilk were substituted. These last two named products were fed the flocks and broods as a beverage, giving extremely good results.

Summary

A summary of all lines of effort is as follows:

Letters written during past year	4,179
Advisory visits to farmers, including those in connection with projects	590
Lectures given	237
Total attendance	10,511
Educational demonstrations given	154
Total attendance	2,274

This year 292 major and minor projects were conducted as follows:

Total number of major projects 51, as follows: No. 3—1; No. 4—22; No. 5—26; No. 6—2.

Total number of minor projects 241, as follows: No. 2—232; No. 3—1; No. 5—8.

During the year 3 poultry educational exhibits were held, conducted along the following lines: poultry housing, poultry feeding, poultry stock, and marketing poultry products. These exhibits were very extensive and complete.

Four circulars published as "Hints to Poultrymen," were written by the extension specialist, viz.: The Profitable Capon; Colony Brooding; Early Mating and Hatching; and Green Feed for the Poultry Flock.

RECOMMENDATIONS

It is recommended that in the next year not more than two major poultry projects be conducted in a county, and that these projects

be very complete in every detail; that monthly reports be obtained; that records be complete and up-to-date; that at least one, and preferably more, local meetings be held as these demonstrations; and that the time allotted to project work in poultry husbandry by the extension specialist and the county agents be used first on these major projects and that the minor projects and advisory poultry work be done after this work is completed.

REPORT OF THE EXTENSION SPECIALIST IN DAIRY HUSBANDRY

J. W. Bartlett

During the past year, there has been a very lively interest among New Jersey dairymen. War prices of dairy feeds narrowed the margin of profit in milk production, until the farmers were obliged to demand better returns for their product. In the fall of 1916, nearly all the dairymen in the counties of Sussex, Warren and Hunterdon became members of the Dairymen's League. Through this organization, a scale of prices has been obtained since that time. The dairymen of South Jersey are now affiliated with the Inter-State Milk Producers' Association. This organization began to benefit the farmers about July 1. Up to this date, however, several carloads of dairy cows were sold from the counties of Salem, Burlington and Cumberland.

At the present time, the general public is beginning to realize the great value of milk as food, and farmers are getting better returns for their labors.

During Agricultural Week in December, 1916, a State Dairymen's Association was organized. An executive committee of 7 active dairymen was appointed to cooperate with the Animal Industry Committee of the State Board of Agriculture in furthering the dairy interests of the state. The extension specialist in dairying was made secretary of the dairy association committee.

Dairy Record Associations

Dairy record associations have become more popular than ever this year. The five which have been in existence for some time are keeping up their membership, and 3 new associations have been organized since January 1, 1917.

The Cumberland County Association was organized by County Agent Oley and the extension specialist in dairying during the month of February. This association has 15 members controlling about 300 cows. The Middlesex-Somerset Association, organized by County Agent Owen and the dairy extension specialist, began work March 1. The membership is now about 22 with 400 cows on

test. The supervisor of this association receives $2 per working day as his compensation.

The last association organized was in Mercer County. Actual record keeping began May 1 of this year with 21 members owning about 400 cows.

At this time there are associations in Bergen, Burlington, Cumberland, Mercer, Middlesex, Somerset, Salem and Sussex counties. The total membership of the combined 8 associations is 135, and there are 3195 cows being tested and recorded each month.

The supervisors of all the associations are now sending in detailed monthly reports to the extension specialist. These reports show that 80 per cent of the herd sires used by the association members are pure-bred. This single item proves that New Jersey stands near the top as a state in the breeding of pure-bred cattle.

Dairy Feeding Demonstrations

Several feeding demonstrations were carried on during the winter of 1916 and 1917. These demonstrations were divided into two periods of one week each. During the first period, the cooperator was obliged to feed his regular dairy ration, keeping individual records of milk production and feed consumed. At the end of this period, the ration was made more practical, and the cooperator induced to feed according to production, at the same time continuing the records. A comparison of the total production, cost of feed and returns above feed cost, was made to show the advantage of the practical ration. Details of this work will be given by the county agents. In several cases the financial saving to the dairyman was one cent per quart of milk. In a number of instances dairymen have seen the benefit of keeping records, and have asked the extension division to furnish them with daily milk record sheets.

Calf Feeding Demonstrations

The use of the home-mixed calf meal as a substitute for milk has been advised very generally throughout the state this year. This mixture was first tried out at the Indiana Agricultural Experiment Station, where it proved very successful. Demonstrations have been carried on in the state as follows: Sussex County 11, Middlesex 1, Somerset 3, Essex 1, Mercer 2, Burlington 4, and Mor-

The demonstration in Essex County was at the Fairfield Dairy Farm at Caldwell, where 90 calves were fed on the mixture. The rate of growth of individual calves averaged 1.1 pounds per day at a cost of 12 cents per pound of gain.

Following is a detailed report of the demonstration carried out by J. P. Van Zandt, of Blawenburg, New Jersey:

Month	Calves No.	Milk Lbs.	Corn Lbs.	Oats Lbs.	Bran Lbs.	Hay Lbs.	Silage Lbs.	Calf Meal Lbs.	Cost of Feed	Cost per Calf
Feb.	4	200	20	45	45	200	...	90	$15.05	$3.76
Mar.	5	300	40	40	40	270	600	65	17.10	3.42
April	8	200	50	122	110	450	300	125	21.62	2.70
May	8	...	50	50	50	500	Past're	...	25.30	3.17
June	8	...	100	100	50	...	Past're	...	16.20	2.02
July	8	...	100	100	50	...	Past're	...	16.30	2.02
Total		700	360	457	345	1420	900	280	111.47	$16.89

These calves were weighed at birth and will be weighed again at the age of one year, when the rate of gain will be calculated.

Soiling Crops

During the spring of 1917, when feed prices were so very high, it was thought best to outline a soiling system for the season for dairymen who had no silos.

Mr. E. A. Schmalz, of Stirling, N. J., cooperated with the extension specialist in this project. By using a system of rye, oats and peas, corn and soybeans, Mr. Schmalz was able to dispense with a 50-acre pasture which he usually rented. He also had the extra services of one man formerly employed to watch the cows while on pasture. It was found that 2 acres of rye sown in the fall would furnish 20 cows with green feed for about 3 weeks during May. One acre of oats and peas was planted the first of April and was ready June 1. A second acre was planted April 15, and was ready to feed about June 15. Two acres of corn were planted May 10, and fed about July 10. The rye ground was planted in soybeans about June 10, and this crop was ready about August 20, as a soiling feed. This system used only 6 acres of land, and the cows were fed at the rate of 60 pounds of green stuff a day.

Organizing Boys' and Girls' Dairy Clubs

The extension specialist gave 5 milk-testing demonstrations during the fall of 1916 at schools in Salem and Warren counties, where junior cow-testing clubs were organized. These clubs were visited with the state leader of club work several times during the contest. This kind of club work has been continued this fall, and in addition, 4 calf-raising clubs have been organized. As an educational feature of the calf clubs, dairy cattle judging is being taught in preparation for a junior judging contest.

Bull Associations

There is a growing demand for bull associations, and while no definite work has been done on the project as yet, it will receive attention this winter.

Forty farm visits have been made on request, and several of the farms visited are cooperating fully with the extension division in carrying out their dairy methods. The activities of the extension specialist in dairying have been: number of farms visited 570, number of meetings addressed 36, attendance 1350, letters written 765, circulars prepared 1.

REPORT OF THE STATE HOME DEMONSTRATION LEADER

M. Anna Hauser

Much progress has been made in home demonstration work in New Jersey during the past year. Owing to the food situation in the country, the demand for women's work has been unusually great. Besides the county home demonstration agents who will be mentioned later, two new specialists in home economics were added to the staff. Miss Carrie M. Pimm began work February 15, and Miss Helen E. Minch began work June 26. The work throughout the state was carried on by the state home demonstration leader, the specialists who went out from the college and the three home demonstration agents who were placed in counties.

This year the energies of the young women in the counties and of the specialists at the College have been directed for the most part toward emergency food conservation, the regular work of organization and that of a more educational nature being temporarily discontinued. The work this summer consisted largely of demonstrations given on canning and drying vegetables and fruits. The winter's program is made up with the idea of teaching people the economical use of wheat, beef, sugar, fat, etc., and demonstrations are planned to show how other foods may be substituted for these staple foods without danger of impairing the health of our people.

Conditions for the development of the home demonstration work have been made very favorable by the director of extension. The county farm demonstration agents also have shown the finest spirit of cooperation, without which the degree of success which has been attained would not have been possible.

Work of the Specialists

The work of the specialists is to carry on home demonstration work in unorganized counties and to assist the county home demonstration agents. The total number of meetings held by the specialists throughout the year is 225, and the total number of people reached is 22,888. There were 121 canning demonstrations, 26 demonstrations on the drying of fruits and vegetables, 43 demonstrations along other lines and 36 talks or lectures. During the year

service was rendered to the following organizations: farmers' institutes, granges, women's clubs, civic associations, parent-teacher associations, home defense leagues, county boards of agriculture, etc. Demonstrations were given at a great many community meetings arranged for by public-spirited persons. The attendance at the demonstrations during the summer ranged from 100 to 400 people and in several instances the audiences numbered 600 to 800. A demonstration given at a pure-food show in Trenton reached 600 people. Five times service was given by judging domestic science and domestic art exhibits. Another feature of the home economcis work was the writing of 41 newspaper articles and 3 pamphlets on food conservation subjects. The titles of the pamphlets are: (1) "Good Food at Little Cost," treating of the whole grain hominy and cornmeal dishes, (2) "Save Vegetables and Fruits for Winter, Home Canning Instructions," and (3) "The Drying of Fruits and Vegetables." In addition to these, sets of recipes were compiled on the following subjects: "Pickling," "Uses of Sour Milk," "Uses of Stale Bread" and "Meat Substitute Dishes." A great many people were served by having questions answered through correspondence. The total number of letters written is 3475 and the number of circulars distributed 23,442.

County Organization

In order that the most satisfactory and lasting results of this work may be achieved, it was believed by all who were vitally interested in its promotion that a strong county organization should be developed. The first step in this direction was taken when about July 1, 1916, the county boards of agriculture in the different counties began to accept the plan of reorganization that provides for community representation. Under this new plan of organization a constitution has been adopted which provides that women's work be placed on an equality with men's work in the county. The women of our state have been very quick to take advantage of the opportunities afforded them. Three of the counties, Monmouth, Mercer and Bergen, have felt the need of additional home economics work to the extent that the people in these counties were willing to raise part of the necessary funds to place a woman representative of the College in the county. On June 1 Miss Eunice Straw took charge

of the work in Monmouth County; and on June 15 Miss Lauretta P. James took up the work in Mercer County, and Miss Carolyn Wetzel took charge in Bergen County.

The home demonstration agent in every case is a trained and experienced woman employed jointly by the county, State College of Agriculture and the United States Department of Agriculture to work exclusively in the county for the improvement of home and community conditions. In this work she carries out the wishes of the women's executive committee in the county and is subject to the supervision of the state home demonstration leader whose field of endeavor comes under the director of extension in agriculture and home economics.

Home demonstration work depends largely for its success upon the local leadership of the women in the organized counties. What has been accomplished is but a step when compared with what will be accomplished when the women of the state as a whole realize their responsibility and ownership.

A few statistics will give a clearer idea of the amount of work that has been accomplished and also show the appreciation on the part of the people of the opportunities at their command. We have reason to believe that one of the greatest results of the work of the home demonstration agents is the influence that they have had on the character and lives of people. The good that has been accomplished in this direction cannot be listed in such a report as this.

Bergen County

Miss Carolyn Wetzel, Home Demonstration Agent

During the five months in which the home demonstration work has been carried on in Bergen County, 53 canning demonstrations were given with an attendance of 4189 women and girls. There were 13 demonstrations on the drying of vegetables and fruits at which the attendance was 820. Seven lectures also were given at which 1371 people were reached. The winter work on food conservation was begun by giving 3 demonstrations on the "Uses of Wheat Substitutes." The total number of meetings is 77 and total attendance 6275. The lectures and demonstrations were given at community meetings held in schools, churches and grange halls; also at meetings of women's and girls' clubs. At three different times visits

were made to canning centers and help was given to the persons in charge. One new girls' club was organized. Exhibits were made and demonstrations given by teams from the girls' clubs at the Bergen County Fair and also at the Trenton Inter-State Fair. Miss Wetzel reports 56 office calls, 338 telephone calls, 9 articles published, 417 letters written, 962 circular letters sent out and 5727 bulletins distributed.

Mercer County

Miss Lauretta P. James, Home Demonstration Agent

The home demonstration work in Mercer County also has been carried on five months. During this time 28 canning demonstrations were given and service thus rendered to 646 women and girls. There were 7 demonstrations on the drying of vegetables and fruits. One demonstration also was given on each of the following subjects: "Jelly Making," "Left-overs," "Uses of Sour Milk," and 5 demonstrations on "Meat Substitutes." The winter work of conserving food was begun by giving a talk on "Food Conservation" and 3 demonstrations on the "Use of Wheat Substitutes." In all 1044 people were reached at the 47 meetings. These demonstrations were given in connection with grange programs, community meetings, schools, women's clubs and girls' clubs. A class was organized for the instruction of working women. Five lessons were given with an average of 10 persons present at each meeting. Assistance was given to one of the boys' camps by introducing the use of a home-made fireless cooker. An exhibit of canned goods was made at the Trenton Fair and demonstrations by teams from the canning clubs of Mercer County, under the direction of Miss James, also were given. One new canning club was organized. Assistance was given to women's clubs in arranging winter programs. Miss James reports 15 office calls, 130 telephone calls, 2 articles published, 132 letters written and 352 bulletins distributed.

Monmouth County

Miss Eunice Straw, Home Demonstration Agent

The home demonstration work has been carried on in Monmouth County for 5½ months. Thirty-eight canning demonstrations were

given with an attendance of 2143 women and girls. There were 18 demonstrations on the drying of vegetables and fruits at which 734 persons were addressed. Six sewing demonstrations and 3 talks also were given. The winter work of food conservation was started by giving a demonstration on the "Uses of Cornmeal." The total number of meetings held is 63 and the total number of people reached 3050. The demonstrations and lectures were given at community meetings held in schools, churches and grange halls; also at meetings of women's and girls' clubs. Exhibits were made and demonstrations given by teams from the girls' clubs at the Monmouth County Fair and also at the Trenton Inter-State Fair. In cooperation with Miss Fannie F. Cooper, state leader in girls' club work, assistance was rendered in starting a canning center at Oceanic at which 1007 quarts of vegetables and fruits were canned during the summer. One of the canning demonstrations by Miss Straw gave definite help in the work that was done at another canning center in the county located at Deal, New Jersey. About 60 women cooperated in running this plant and 4000 quarts of vegetables and fruits were canned. Miss Straw reports 141 telephone calls, 21 homes visited, 1 article published, 385 letters written and 1954 bulletins distributed.

Conference

Two conferences for all the extension workers in home economics were held during the year. These meetings have proved of great value in developing and organizing the home demonstration work. A state-wide home economics conference was held at Trenton January 26, 1917. This brought the extension workers in contact with local leaders from all parts of the state.

Community Canning Centers

A definite service was rendered by giving assistance in organizing 8 community canning centers throughout the state. Thousands of quarts of fruits and vegetables were saved in this way, that would otherwise have gone to waste. The work done in this direction was a good beginning, and plans are being made to develop it on a much larger scale next year. An effort is being made to determine the

amount of food conserved in these centers and also by women in private homes, but the information could not be secured in time to be included in this report. Women in single homes report that they have canned from 500 to 1000 quarts of fruits and vegetables. The total number of quarts of food saved by the women of our state as a result of demonstration work, it is estimated, will be high in the millions.

Fairs, Exhibits and Demonstration Trains

Exhibits of canned and dried vegetables and fruits were made at three county fairs, at the Inter-State Fair at Trenton and at a number of local grange fairs. Demonstrations were given in connection with these exhibits. During the month of July the home economics extension department cooperated with the Lehigh Valley Railroad Company in a two weeks' thrift campaign. A train known as the "Canning Special" stopped one day at each place scheduled. Canning demonstrations were given each afternoon and demonstrations on the drying of vegetables and fruits were given each evening. An exhibit car accompanied the demonstration car.

Resignation

Only one resignation went into effect during the year. Miss Carrie M. Pimm resigned and discontinued her work October 31, 1917.

Emergency Home Demonstration Work

In order to meet the needs of the present food situation in the country, Congress has made an appropriation to place additional trained women in the field to do emergency home demonstration work. The money from this appropriation became available August 15, 1917, and steps were immediately taken to enlarge the staff of home economics extension workers. The young women added through the use of the emergency funds are known as emergency home demonstration agents and are being placed as fast as cities and counties make request and indicate their willingness to bear a small part of the expenses necessary to the carrying on of this work.

Emergency home demonstration work differs from the regular home demonstration work previously carried on in that it aims to meet the immediate needs of the people and does not deal so much with organization and work of a more educational nature. The great problem that confronts us to-day is embodied in the following: "How can we feed our soldiers, our allies and our nation of people at home?" The home demonstration agents are putting forth all their efforts to help solve this problem. They are doing it by giving demonstrations and lectures on "Food Conservation." They are showing the cooking of simple dishes prepared from corn and certain other available food products that people have not been accustomed to using in such large quantities, nor in such a variety of ways in the past. The importance of this work lies in the fact that it will be the means of keeping thousands of our people from starving during the coming winter and prevent rioting in population centers. It will also aid materially in conserving next year's food crop.

Since the emergency home demonstration work is just being organized it is impossible to give very definite information regarding the accomplishments in this report.

The following persons have already begun work:

Miss Nelle Johnson, a graduate of Columbia University, began work August 20 and is supervising the emergency home demonstration work in the large cities of the state. Her headquarters are at New Brunswick.

Miss Regine Porges, a graduate of Columbia University, began work September 1 and has been placed temporarily in the city of Passaic.

Miss Margaret Hartnett and Miss Mabel Tallant, both graduates of Columbia University, began work September 20. Miss Hartnett was placed temporarily in charge of the work in the city of Paterson. Miss Tallant is temporarily in charge of the home demonstration work in Sussex County.

Miss Josephine Cramer, a graduate of Columbia University, began work October 3, and is temporarily in charge of the work in Middlesex County.

Miss Harriott Ware, a graduate of Columbia University, began work October 15, with headquarters at the central office in New Brunswick.

Miss Margaret C. Hayes, a graduate of Columbia University, began work October 25 and is temporarily the home demonstration agent in Morris County.

Miss Clara Forte, a graduate of Columbia University, has been engaged to begin work November 5, 1917, and plans have been completed to place her temporarily in Burlington County.

From the outset women's clubs and other associations have been making requests for assistance that furnish a wide scope of usefulness for these workers. At present these young women are busy giving demonstrations on "Making War Breads," "Uses of Cornmeal," "Meat Substitutes," "Uses of Stale Breads," "Uses of Sour Milk," etc. Emergency home demonstration work will be organized in additional counties and cities as soon as trained women can be secured and arrangements can be made with local authorities for starting this work.

REPORT OF STATE LEADER OF BOYS' AND GIRLS' CLUB WORK

A. M. Hulbert

The writer assumed the duties of this office April 9, 1917, as leader of boys' and girls' club work in the state. Since July 1 boys' clubwork and girls' club work have been under one leadership. All projects and club work that had been started under Mr. McCallum have been continued.

The state leader began work at the time when the campaign for the increased production of food was at its height and just at the time when many public schools of the state were closing their year's work. The organization of new clubs and the starting of new projects was particularly difficult. The policy of helpful cooperation in all lines of work that was then under way was adopted. At the same time a study was commenced of the conditions as they then existed in the state with regard to what had been accomplished and to the possibility of further organization and of establishing a close relationship of coordination and cooperation between the State Department of Public Instruction and the extension division of the College of Agriculture. It was found that in nearly every agricultural county in the state a great deal of work had been done in the schools in industrial and home-making contests through the cooperation of the county farm demonstrator, county superintendent of schools, supervising principals, teachers, county Y. M. C. A. secretaries and other agencies. There had not been, however, any policy adopted in the state providing for the teaching of agriculture or home economics in the elementary schools or for standardizing the work embraced within the contests, and there was no agreement of cooperation between the Department of Public Instruction and the extension division. The task for the state leader seemed to be not so much a matter of arousing interest and of creating sentiment as to directing them. It became apparent, through the evident willingness of school superintendents and county farm demonstrators to cooperate, that the wiser thing would be to work through institutions and organizations already existing rather than to create new organizations. To that end a number of conferences have since been held between the Department of Public Instruction and the extension division, and

it has been agreed that club and junior project work for boys and girls offers much that is of practical value and that they should readily find a place in the elementary schools and in such high schools as have not already provided instruction in agriculture and home economics. It has also been agreed that cooperation in this work is desirable and the plan adopted for the ensuing year provides for the following essential features:

1. A limited number of county leaders from the teaching staff of the counties shall be employed on such terms as to secure a part of their time during the months that schools are in operation and their entire time during the summer vacation months for organization and supervision of boys' and girls' club work.
2. The extension division is to direct and supervise all project work from the agricultural and home economics point of view, and the Department of Public Instruction is to have within its jurisdiction everything that pertains to the place that club work shall have in the schools.
3. The extension division is to outline all projects in cooperation with the county farm demonstrator and county superintendent of schools.
4. Cooperation of teachers is to consist in assisting in enrolling members and in giving moral support and encouragement, and in giving leaders the opportunity when visiting schools, to meet teachers, conduct demonstrations and give such instructions as may be necessary to carry out any given project successfully.
5. The cooperation of teachers is to be voluntary and is requested by the Department of Public Instruction.
6. The extension division will furnish such literature, forms, etc., as may be necessary.
7. Teachers cooperating are to give such assistance to club members as may he necessary in keeping complete records of all work done.

In organized counties the work is to be carried on through the county leader who will work under the direction of the state leader in consultation with a county advisory board which will consist of the county superintendent of schools, the county farm demonstrator, a representative of the county board of agriculture and representatives of such other organizations and such individuals as the committee may invite to cooperate with them.

Up to the present time three counties have been organized under county leadership and plans for the organization of four other counties are well under way. This plan for the organization of boys' and girls' clubs and junior project work in New Jersey is put forth as indicating a policy which it is hoped will become the permanent policy in the state. Requests for assistance in the organization and supervision of boys' and girls' clubs in New Jersey are increasing. Requests are being made to have work that is now in the hands of private or semi-public organizations taken over by the

state leader, and plans are under way for such adjustment and arrangement in several parts of the state. For the ensuing year and as long as the present food emergency continues, the policy of the state leader will be so to direct the activities of the state organization as to meet the demands for increased food production and conservation and at the same time to work for the building up of an efficient organization.

At the present time there are two assistant state leaders: Miss M. Ethel Jones, who will have charge of the girls' work, and Mr. Charles Orchard Smith, who will assist in organizing and supervising boys' work.

REPORT OF STATE LEADER IN GIRLS' CLUB WORK

FANNIE F. COOPER

The girls' club work was organized in June, 1915. It includes work with women and girls in the organized communities of the state, and is carried on in cooperation with the county farm and home demonstration bureaus, public schools, women's clubs, granges, Y. W. C. A.'s and any other organization which may exist in a community. The aim of the club work is to interest the women and girls of the state in coming together to study the best methods for solving the problems of home making as presented in demonstrations given by the state leaders and the club members.

The demand for the organization of mother-daughter clubs was so very great that it was necessary to add a second worker. Miss Helen E. Minch was appointed on January 1 to assist with this work, and from that date until July 1 she worked with the state leader.

During the first two years demonstrations were given to the women and girls by the state leader, but there was no one to follow up the work with the girls between demonstrations. By this method only a small number of clubs could be successfully carried on. In order that more women and girls might have the opportunities that are offered to the organized groups, a committee of 4 women, representatives of the different organizations of the community, and a local leader were secured to follow up the work in each community. Several demonstrations were given by the state leader which were open to all the women and girls of the community. Additional demonstrations were given to the girls of the organized groups by the local leaders, assisted by one or two members of the committees. At these demonstrations the girls canned fruits and vegetables under the supervision of those in charge. This plan made it possible for the girls to do actual work in canning under the supervision of the leaders. In some cases meetings were held once in two weeks, and in many communities weekly meetings were provided for. Far better results were secured by the girls in club rooms where the work was carried on according to this plan than had been possible in previous years with only one person to give all the instruction.

During the past year there were 16 counties doing organized club work, with a total enrollment of about 1500 members. This makes

an increase over last year of 4 counties and about 600 members. These members are enrolled in 62 clubs with a local leader for each group. The local leaders assumed leadership of these groups and assisted the state leaders in the local follow-up work, such as holding club meetings, visiting club plats and keeping up the active interest in the work. The help of one paid leader was secured who held weekly meetings with the club members and visited each garden plat three times during the growing season. The mother-daughter club has been shown to be the most effective way to interest the women and girls in the home and to bring mother and daughter together to study the social and economic problems of home making; to bring about closer fellowship and cooperative spirit in rural and village communities; to preserve food by canning and drying, thus reducing living expenses; to teach thrift and to encourage organized effort and team work; to encourage ownership and to train for efficiency in home making. In many communities this work affects not only the social life and activities of the home, but also the community at large.

The girls' club work during the past year consisted mainly of demonstrations in canning and drying fruits and vegetables, home gardening, cooking vegetables, cooking milk and eggs, bread-making, cooking the cheaper cuts of meat, giving instruction on the construction and use of the home-made fireless cooker and packing school lunches. Some time was also given to the organization of girls' canning clubs, mother-daughter clubs and to personal visits to club plats, placing exhibits, judging domestic science exhibits, training demonstration teams, directing canning contests, answering by letter inquiries on club work and home economics subjects and preparing follow-up instructions for club members.

The demand for canning and drying demonstrations from unorganized communities became so great that it was necessary for the state leader to give time to meeting the emergency work. In addition to directing the club work during the summer months, the writer took charge of the canning and drying work at our state institutions, also visited the state institutions to assist them in saving the surplus fruits and vegetables by giving canning and drying demonstrations to those in charge of that work.

Summary of Activities

The total number of meetings held during the year is 183 with a total attendance of 11,014; 130 of these were club meetings with a total attendance of 6,670. There were 46 canning demonstrations with a total of 3,552 people in attendance, 5 drying demonstrations with a total attendance of 356, 14 bread-making demonstrations with a total attendance of 4,319, 28 fireless-cooker demonstrations with a total attendance of 1,103, 6 demonstrations on cooking the cheaper cuts of meat with a total attendance of 102, 3 milk-and-egg demonstrations with a total attendance of 146, 15 vegetable-cooking demonstrations with a total attendance of 648. Thirty-seven other demonstrations were given to unorganized groups with a total attendance of 4417. Eleven talks were given on the opportunities for mother daughter and home gardening, the estimated attendance being 469. These talks and demonstrations were given to mother-daughter clubs, girls' canning clubs, farmers' institutes, granges and home and school associations. The girls' clubs from 5 counties sent an exhibit of about 800 quarts of fruits and vegetables to the Trenton Inter-State Fair. Six club groups in Monmouth County exhibited 600 quarts of fruits and vegetables at the county fair. Four club groups in Bergen County exhibited 150 quarts of fruits and vegetables. Many other small exhibits were made by the club members at meetings held in their respective communities. Six domestic science exhibits were judged. Sixteen demonstration teams were trained, 8 of these competed in a canning contest held at the state fair for a trip to the Eastern States Exposition at Springfield, Mass. Six girls from New Jersey were chosen to represent this state in canning and judging contests to be held at the Exposition. During the past year 1,539 letters were answered on inquiries regarding the organization of the girls' and mother-daughter clubs, also on different projects taken up by the groups; 3469 circular letters were distributed, giving club members timely instruction for carrying on their work. About 3000 persons were benefited by the demonstrations given at the 8 state institutions. These institutions were visited 18 times and 16 canning and drying demonstrations were given. At each visit the writer conferred with those in charge in regard to the necessary equipment for canning and drying on a large scale.

Up to the present time 310 reports have been made by the club members, showing a total of 29,383 quarts of fruits and vegetables

canned (12,845 quarts of fruits and 16,538 quarts of vegetables). Many quarts of canned meats and pickles were reported by the club members, and also large quantities of jellies.

At the time of writing this report only about one-fifth of the club members have reported. The percentage of reports received this year will, no doubt, show a great decrease over those received last year, due to the fact that a false rumor has been spread abroad that the Government intends to seize all over 100 quarts of canned products stored in any home. However, even though only 310 reports have been received, we feel that practically every member enrolled in the state clubs has been saving the surplus fruits and vegetables and, in the writer's opinion, it is a safe estimate to place the amount of food conserved through the efforts of the state canning clubs alone at 100,000 quarts.

REPORT OF THE DEPARTMENT OF AGRONOMY AND FARM MANAGEMENT

Department of Agronomy
and
Farm Management

FRANK APP, B.S., *Agronomist.*

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Report of the Department of Agronomy and Farm Management

Frank App

INTRODUCTION

The work of the department of agronomy and farm management may be summarized under the following heads:

Field Crops

1. Proper sources of alfalfa seed for New Jersey.
2. Time of seeding alfalfa.
3. Alfalfa cultivation.
4. Sweet clover seeding.
5. Selection of ensilage seed corn.

Farm Management

1. Study of Sussex County dairy farms.
2. Study of Monmouth County general farms.
3. Study of Monmouth County dairy farms.
4. Study of New Jersey poultry farms.
5. Study of Monmouth County truck farms.
6. Cost of milk production.

FIELD CROPS

Proper Sources of Alfalfa Seed for New Jersey

Because of the great difference found in alfalfa seed grown in different parts of the United States and Europe, it was deemed advisable to determine which are the most satisfactory sources and strains for New Jersey. This work is being carried out in cooperation with farmers throughout the entire state, since it would appear

necessary to try all of these sources in different parts of the state in order to be sure that they are satisfactory for the varied conditions of soil and climate of New Jersey.

Plots 1 rod square were laid out and seeded with alfalfa seed from 17 sources or strains as follows:

1. Cooperator's Seed.
2. Common, Campbell, Nebraska.
3. Common, Buena Vista Warehouse, Texas.
4. Common, Danzer, Kansas.
5. *Grimm, Aberdeen Experiment Station, Idaho.*
6. Common, Danzer, Montana.
7. Common, Aberdeen Experiment Station, Idaho.
8. Common, Patterson Seed Co., South Dakota.
9. Turkestan, Nungessor-Dickinson, New York.
10. Cooperator's Seed.
11. Common, Wells, Idaho.
12. *Grimm, Miles City Association, Montana.*
13. Liscomb, Miles City Association, Montana.
14. Variegated, Ontario Experiment Station, Guelph, Canada.
15. Common, Alfalfa Association, South Dakota.
16. Grimm, W. R. Porter, North Dakota.
17. Common, McMahon, North Dakota.
18. Common, Maxon, South Dakota.
19. *Grimm, Hereford, Colorado.*
20. Cooperator's Seed.

This work has just been started this year, and conditions were exceedingly unfavorable for newly-seeded alfalfa during August, 1917, because of the prevailing drought. Consequently, many of these plots are not looking well at the present time. It will require from 3 to 5 years to determine effectively the superior strains and sources of seed for the state.

Time of Seeding Alfalfa

Because of the varied conditions throughout the state in soil and climate, it seems that it might be desirable to seed some alfalfa early in the spring, rather than in August, especially throughout North Jersey. To throw some light on the different times of seeding, plots were seeded at the following dates on the Experiment Station Farm: April 11, June 7, and August 14, 1917. Three lots of alfalfa were seeded on April 11 as follows: on corn stubble disced, harrowed and seeded; on corn stubble plowed, harrowed and seeded; and with wheat as a nurse crop. The last method proved far superior, since both plots without a nurse crop were over-run with

weeds, and did not make satisfactory growth. The plots seeded on June 7 were more weedy than those seeded April 11 without a nurse crop, while the August seeding is going into winter in fair condition, but small.

Alfalfa Cultivation

The results of this year's work of alfalfa tillage—on alfalfa in rows, alfalfa mixed with timothy, and alfalfa alone—on a heavy Alloway clay loam, continue to show that cultvation has not been desirable in raising this crop. The yields are not so large, and the life of the plant is not prolonged, while the labor is increased. Alfalfa with timothy has proved quite satisfactory. The plots are becoming quite thin, and it may be necessary to plow them up next year, after passing through the winter.

Sweet Clover Seeding

Inasmuch as sweet clover is commanding considerable attention, preliminary methods of seeding were started in 1916, to determine what were the most practical methods of obtaining a stand. A good stand was secured by seeding with the wheat as a nurse crop quite early in the spring (the latter part of February or early March) in the latitude of the Experiment Station Farm. During the past year a luxuriant crop was produced from this seeding, a portion of which has been left for natural reseeding, to ascertain whether it will maintain itself as a pasture once it gains a foothold. The result of the natural reseeding will be reported next year.

Selection of Ensilage Seed Corn

At the request of Mr. H. W. Jeffers, manager of the Walker-Gordon Farms, a project was started to determine if it is practicable for the New Jersey farmer to select his own ensilage seed corn from the large varieties, such as Eureka and Southern Horsetooth. Results of the 1917 crop indicate that the selected grain showed a superior germination to the purchased seed, and that it was highly desirable to select the ensilage corn from the standing stalk in order to improve it, and modify the plant so that it would meet the dairymen's needs most effectively. Consequently, it not only gives a better grade of seed, but will also give a more vigorous and productive plant.

FARM MANAGEMENT

Study of Sussex County Dairy Farms

This study shows that Sussex County, New Jersey, is one of the most efficient dairy counties of the United States. The study was made from 300 owner and 160 tenant farms. The following is a summary of the results obtained in the study of the 460 dairy farms.

1. An error of one-tenth per cent was found in the milk sales reported by the farmers when checked with what the milk companies actually bought.

2. There were 300 owners, 95 share tenants, 65 cash tenants, and 21 labor-share tenants in this area.

3. Landlords renting for cash receive the lowest return on their investment.

4. The landlord's return on his investment varies from 2 per cent to over 16 per cent.

5. But one-sixth of the owners, one-ninth of the share tenants, one-fourth of the cash tenants, and one-twentieth of the labor-share tenants made a labor income above $1000.

6. The average capital invested was $11,259 for the owners and $13,112 for the tenants.

7. The number of crop acres per farm was 58.2 for owner farms and 71.7 for tenant farms.

8. The total farm area was 153.9 acres for owner farm and 195.7 for tenant farms.

9. Large farms were more efficient in the use of man, horse, and machinery labor.

10. The crop-acre value decreased with the larger farms, but the farm acre value remained about the same.

11. Crop yields on large farms were as good as on small farms.

12. Large farms were most profitable.

13. Large herds were most profitable.

14. The average size of herd for the owners was 20.3 cows, and for the tenants 26.3 cows per farm.

15. The building investment per cow was less with large herds than with small herds.

16. The value per cow was higher in large herds.

17. High crop yields returned greater profits.

18. High-yelding farms showed a greater value per acre.

19. Cows giving most milk returned the greatest profits.

20. Cows producing the most milk were valued the highest.

21. Farms selling both crops and stock products were more profitable.

22. Labor was more efficiently used on farms selling both crops and stock products.

23. Poultry was profitable on these farms.

24. The main crops raised were hay, corn, rye, oats, and wheat.

25. Farms located 4 miles or more from the railroad were not so profitable.

26. Farms which had the most work units per man were most profitable.

27. Farms having silos were the most profitable.

28. The annual depreciation on cows was about 8 per cent.

29. The cost of producing a quart of milk in 1914 was 3.84 cents and in May, 1917, 5.61 cents.

30. The major measures for success were production per cow, size of herd and the number of crop acres.

31. Chickens or fruit should be added on these farms for diversity and greater profits.

Monmouth County General and Dairy Farms

The results of the survey of these farms are now in the press and are being published as Bulletin 312 of the Experiment Station. The general principles of the study are very much the same as those of the other studies of this state. One rather remarkable feature is that livestock did not seem to affect the profits on the farm to any material extent, either favorably or unfavorably, while on the potato farms of this region livestock was not found to be profitable in most cases.

New Jersey Poultry Farms

A study of the poultry farms is being conducted in cooperation with the poultry department, with the assistance of Prof. H. R. Lewis, poultry husbandman. The following is a brief summary of the results of the poultry farm survey by Mr. Allen G. Waller, who took the records.

NEW JERSEY POULTRY SURVEY

Poultry and poultry farming are commanding much attention at present and interest in the industry is growing with the higher price of poultry products. Agricultural papers give examples of small flocks of hens making so much profit per hen over and above feed cost. Such allusions lead many inexperienced people into the business in the same way as the smooth-tongued gold brick swindler of former days enticed victims to invest in products of doubtful value.

The proof of profit in any business is shown when we find a large number of people who make their living following such a business. If they are comfortably housed, prosperous and happy, then we may feel confident that the business they follow allows satisfactory profit for a living.

The number of families who make their living entirely from poultry and egg production is relatively small in the United States. Of these few New Jersey has a large proportion for the size of the state. Probably no other state outside of California has so large an area so exclusively devoted to poultry as New Jersey. This allows a most admirable opportunity for the study of poultry raising as a type of farming in itself. Much has been written and said about the farm flock but little has been done to place poultry raising and egg production on the level with dairying or other specialized types of farming.

During the past winter the writer, under the direction of Prof. Frank App, head of the agronomy and farm management department of the Experiment Station, and of Prof. H. R. Lewis, head of the poultry department, made a survey of the New Jersey poultry farms for the purpose of studying poultry farming as a business. This survey is of the poultry farms in the Vineland, Lakewood and Sussex County areas. Records were obtained for 150 farms.

The data from these farms include detailed records of receipts and expenses for the year November 1, 1915 to November 1, 1916, for each farm. On 98 farms the egg and chicken receipts together with the feed expenses were taken directly from the poultrymen's book accounts. On the remaining farms the poultrymen made careful estimates aided by partial records.

These farms were being run almost entirely for poultry products, of which egg sales produced 74.5 per cent of all receipts and meat sales 15.3 per cent. White Leghorns were kept almost exclusively; there was but one of the 150 commercial plants that did not keep any White Leghorns, this one having a flock of Anconas. On November 1, 1915, White Leghorns represented 97.8 per cent of the total number of hens on these farms and on November 1, 1916, 94.3 per cent. Thus the White Legborn, by its almost exclusive use on these commercial egg-producing farms, seems to have proven itself a satisfactory and efficient breed for egg production. Usually a few birds of the heavier breeds were kept by the poultryman, largely for table use.

Areas Surveyed

Vineland is by far the largest and most intensive of the three areas surveyed; 116 of the 150 complete records were obtained in this section. In addition 57 incomplete records were obtained chiefly from farms where the operator had not been running the place a year or where the operator did not make his entire living from poultry. This number approximately represents the floating population in the poultry business. That is, one out of three fails at making a living from the poultry business, largely because of the following reasons:

1. Lack of experience.
2. Lack of capital.
3. Lack of personality necessary for careful attention to a business made up of so many details as poultry farming.

A most interesting feature of the Vineland area is the variety of localities and occupations from which the men have come to take up the poultry game. All sections of the United States and many trades and professions are here represented. The Vineland area covers a rectangular tract in Cumberland County about seven miles long by five miles wide, including the borough of Vineland which is about one mile square. It is 35 miles south of Philadelphia, and 125 miles from New York City. Most of the eggs produced are shipped to the latter city. Only 75 horses were kept on the 150 farms, the farm areas being small and shipping point near. The soil is light and well drained, which, with the mild climate of Vineland, makes it a favorable location for poultry.

Lakewood. The Lakewood poultry section is 63 miles from New York City and about 13 miles from the shore resorts. The land is comparatively level and the soils are light, similar to those of Vineland, while the climate here also is mild. The poultry farms in this section are much more scattered than those of Vineland and are larger in area.

Sussex. The Sussex poultry area differs considerably from the Vineland and Lakewood sections. Located in the northwestern part of Sussex County in the hills and valleys along the Delaware River, its transportation facilities are poor, its topography rough, and the climate more severe. Port Jervis and Branchville are the two nearest shipping points and the distance from the farms varies from three to seven miles. Branchville is 70 miles from New York City on the D., L. & W. Railroad, while Port Jervis is 80 miles from New York on the Erie Railroad.

Number of Birds Kept

The total number of laying birds on these 150 farms was 107,974 at the beginning and 122,204 at the end of the year. The average size of the flock in the different sections is shown in the following table:

TABLE 1

Size of Flock in the Three Areas

Location.	No. of farms.	Average No. hens at beginning of year.	Average No. cockerels at beginning of year.	Total flock at beginning of year.	Average No. hens at end of year.	Average No. cockerels at end of year.	Total flock at end of year.
Vineland	116	654	16	670	761	21	782
Lakewood	22	894	20	914	957	23	980
Sussex	12	1039	23	1062	1064	23	1087
Totals	150	720	17	737	815	22	837

On November 1, 1916, these farms showed a 13 per cent increase in the total number of birds kept. The average size of flock was smallest in the Vineland area and largest in the Sussex area, but the per cent increases in the size of flock at the end of the year were as follows:

Vineland	16.7 per cent
Lakewood	7.2 per cent
Sussex	2.3 per cent

A large number of hens, up to a certain point, with other factors equal, means a larger-sized business and greater profits.

The Vineland area itself had on November 1, 1916, the following number of birds:

	Pullets	Yearlings	Cockerels	Totals
116 complete records	51,159	29,479	2,120	82,758
57 incomplete records				20,607
				103,365

Of this total number 54,836, or over one-half, were in the southeast quarter.

The largest flock on these 150 farms was of 2,400 birds, and the smallest 113, but these two flocks did not represent the highest and the lowest labor incomes, respectively. The "labor income" represents the profit determined by subtracting from total farm receipts the sum of the total farm expenses and interest on the total farm investment at 5 per cent. In addition to this, the poultryman secures the use of his house and whatever vegetables he may grow, as well as poultry products.

. The capital required is practically the same in all three areas. The labor income varies directly with average size of flock (cf. Table 2 and Table 1). An average labor income of $730 on the 150 farms means approximately a dollar per hen profit for the poultryman's labor, or a farm income of one dollar and a half per hen.

A larger number of birds per acre are being kept in the Vineland area than either in the Lakewood or Sussex areas. The poultrymen in the

Sussex area are raising more crops and farming more extensively than those in the Lakewood and Vineland areas. Carrying the same poultry breeds, and using in general the same principles of feeding and flock management, the degree of intensity (i. e., the number of birds kept per acre) is one of the chief differences between the areas.

TABLE 2

COMPARISON OF LABOR INCOME, CAPITAL, FARM AREA, CROP AREA AND FARM INCOME* ON THE VINELAND, LAKEWOOD AND SUSSEX POULTRY AREAS

Location	Average Capital per Farm	Average Labor Income	Average Farm Income	Average Farm Area	Average No. Crop Acres	Average No. Birds per Farm
Vineland	$7279	$622	$958	8.4	3.3	670
Lakewood	7094	1002	1357	14.5	5.1	914
Sussex	7153	1265	1623	37.2	16.1	1062
Average	7243	730	1092	11.6	4.6	737

The other main difference is in the raising of broilers. In the Vineland area we find that the poultrymen are raising only the cockerels from the very first hatches to broiler age. Most of the cockerels from the later hatches are sold off as soon as distinguishable at the age of three to five weeks for 8 to 15 cents apiece. This is a losing price but it is done for two reasons:

1. With space so limited it is necessary to make room for pullets from the succeeding hatches in order to maintain as large a number of laying birds as possible.

2. The prices of broilers from the later hatches are generally low and leave a narrow margin for profit.

In the Lakewood and Sussex areas we find the broiler business carried on more extensively and almost no young cockerels are sold off until they reach broiler weight. The rations used in feeding follow very largely the New Jersey and Cornell recommendations, with slight modifications in some cases according to the individual poultryman's ideas.

With an average farm area of 11.6 acres, and 4.6 crop acres, these farms are averaging 72 birds per farm acre. Practically all the feed is purchased. Every poultryman tries to raise enough green material for his flock in addition to that found on the ranges. Ranges occupied 3.2 acres per farm, or over 27 per cent of the total farm area; such crops as rye, wheat, clover or occasionally alfalfa are sown in late sum-

*The farm income represents the total farm receipts less the total farm expenses. It differs from the labor income only in that the interest on the capital invested is not deducted from the total farm receipts, as is the case in determining the latter.

mer or early fall and produce a good growth ready for the use of the birds as early in the spring as the weather is fit. Vineland 1 has an advantage over the other areas in this respect as the season for poultry on range is longer. Rape is used very commonly and is sown in the spring, more especially on the young stock ranges.

For winter green or succulent food these 150 *farms* were *growing* 25 acres of mangel wurzels, 11.4 acres of cabbage and 1.5 acres of kale. Occasionally lettuce and sprouted oats were used but found very expensive.

The crop acres are occupied largely by fruit, usually peach trees which take up 1.3 acres per farm, and these are usually on the ranges to furnish shade. The receipts from fruit were unimportant.

Egg Production Per Hen

An *essential factor in making* a profit is the *number of eggs* produced per hen. In figuring future profits a man must know about how many eggs per hen can be expected, and the average prices.

The numbers of eggs sold per hen were as follows: Vineland, 103; Lakewood, 99.6; Sussex, 115. Combining the three areas, 8.6 dozen, or 103 eggs, were sold per hen, and the egg receipts were $2.92 per hen, making the average price received by the poultryman 34 cents a dozen. The total egg production, including hatching eggs and those used in the house, was 109 per hen.

The average *cost of feed* per bird was *$1.66*, which *leaves* an average of $1.28 per hen from eggs produced above feed cost. Until an egg production of 80 to 100 per hen is reached no returns for labor are obtained. A person entering any business should know how wide a range is possible in the factors determining profit.

The range in labor income was $3,867, the highest, to —$1,013, the lowest. When 27 out of the 150 poultrymen, or one out of every 5½, *are losing money and getting nothing for their labor, one should* consider carefully whether he has sufficient capital and knowledge of the poultry business to enter into it.

COMPARISON OF RECORDS ON A PROFITABLE AND AN UNPROFITABLE POULTRY PLANT

	Profitable Plant	Unprofitable Plant
Total Capital	$6770	$7710
Size of Flock	700	700
Eggs per hen	117	72
Feed Cost	$1578	$1300
Labor Cost	Operator's full time	Operator's full time
Other Costs	$273	$313
Labor Income	$1286	—$132
Egg Receipts per hen	3.34	1.81

Here are actual figures from two poultry plants which are worth considering. These two farms are carrying the same number of laying hens, yet the operator of one is losing $132, as compared with profits

of $1,286 for the other operator's labor. Almost the entire difference in profits here is due to an egg production of 117 per hen against 72 per hen. This gives the one poultryman $3.34 egg receipts per hen while the other one is receiving $1.81 per hen. There is no margin of profit on the hen producing but 72 eggs and the poultryman is throwing away his labor when he keeps a flock of this average production.

Certainly with the present high cost of maintaining the flocks, it behooves the poultryman to know not only the average production of his flock but as far as possible the production of each individual in his flock. *But nine of the 150 poultrymen in this survey were regularly trap-nesting.*

Profits will vary directly with egg production per hen and the poultryman must stop carrying the low-producing hen or go out of business, as 74½ per cent of all receipts on these farms was from egg sales.

A more complete study of this survey will at some later date be published as a bulletin of the New Jersey Agricultural Experiment Station.

Monmouth County Truck Farms

The records for these farms have been almost completely tabulated, but have not been studied up to the present time.

Cost of Milk Production

Because of the great agitation concerning the cost of producing milk and the price of milk, a study was made of the Sussex County dairy farms to determine the cost in that county, which is our most favorable locality for producing milk. It was found that on these farms, the dairymen had been producing milk at a loss, and that the price of milk throughout the state in the past has been too low in many cases for the average dairyman to make a profit on his product. *Consequently, it is only those men who use superior methods, who* are above the average in efficiency, and who have had more than ordinary advantages, that have made money on milk production.

MISCELLANEOUS

Emergency Work

During the past year the agronomist has given considerable time to emergency work, especially to the farm labor problem, and other emergency work along farm crops and farm management lines. At the request of the State Department of Agriculture, a trip was made

through the Northwest for the purpose of investigating alfalfa seed production, its marketing, and the most desirable sources.

The following publications have been prepared during the past year:

Bulletin 312. Farm Profits and Factors Influencing Farm Profits on 284 General Farms and 75 Dairy Farms in Monmouth County, N. J.

Bulletin 320. Farm Profits and Factors Influencing Farm Profits on 460 Dairy Farms in Sussex County, N. J.

Circular 69. Corn.

Circular 87. Wheat and Rye.

Needs of the Department

In order to place the agronomy department on an efficient basis, where it could give the proper service to the farmers throughout the state on farm crops, such as corn, potatoes, small grains, alfalfa, clovers, timothy and other forage crops, it would be necessary to have adequate equipment consisting of a building to care for the crops and seed, the use of a team, and two men. It would further be necessary to have an experienced man who is trained for research work in crops and who could look after the details properly. It does not appear that it would be advisable to make this addition during the period of war, because of labor shortage. Consequently, the agronomist will carry on such work as conditions will permit until the occasion will allow proper development.

Financial

The following is a list of expenses for this department for the fiscal year November 1, 1916, to October 31, 1917.

EXPENSES FOR FARM MANAGEMENT WORK

Collecting poultry records	$50
Tabulating farm management records	560
Salary of staff	100
Total	$760

FARM CROPS

Alfalfa tillage		
Labor—		
146½ man hours	@ $.25	$36.63
164 horse hours	@ .20	32.80
		$69.43
Seed		48.00
Salary of staff		100.00
		$217.43

MISCELLANEOUS EXPENSES OF DEPARTMENT

Stenographer	$165.00
Traveling and incidentals	44.69
Total miscellaneous	$209.69
Farm Management	$760.00
Farm Crops	217.43
Miscellaneous	209.69
Total	$1187.12

REPORT OF
DEPARTMENT OF FARM CROPS

Department of Farm Crops

CHAS. S. VAN NUIS, *Farm Manager.*

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Report of Department of Farm Crops

CHARLES S. VAN NUIS

Conditions coincident with the war had an effect upon the planning of field crops and work of the Farm Crops Department for the year just ended.

Heretofore our well drained cultivated areas were insufficient to grow enough alfalfa for hay and corn for silage to feed the cattle kept at the dairy farm through an entire year.

Corn

Corn for husking, with no shortage of silage, would be impossible without additional acreage; accordingly, arrangements were made to have the Board of Trade tractors plow for us 40 additional acres of abandoned land within a radius of ¾ mile of the College Farm. This land was to have been fitted, planted, cultivated and harvested by our farm teams and labor, and the corn not used for silage allowed to mature. The wet spring, and other appointments for the tractors, gave us only 10 acres of corn, besides that planted on our two farms.

A small part of this year's corn crop was husked and used by the animal husbandry department in the production of pork.

Forty acres of well glazed corn yielded 508,936 pounds, cut for the silo. Two and one-half acres of corn yielded 122 bushels of corn on the ear.

The average yield per acre of corn for silage was 12,723 pounds.

At the ruling market prices, ear corn is more profitable than green corn for silage at $6.00 per ton; but the latter is needed for the production of milk, hence the sacrifice of revenue of one department of the Experiment Station for the larger production of milk for human consumption.

Rye

Rye has been grown principally for straw prior to this year, a crop of soybeans usually following, either to mature, to be cut for green forage, or to be turned under for green manure, as seasonal and other conditions might determine.

Rye, on 9 acres of very wet ground, was allowed to mature for grain, the yield being 133 bushels, or an average of 19¾ bushels per acre. All rye not used for seeding will be ground into flour for human consumption.

Four acres of rye were cut green for forage for dairy cattle, the yield being 24,165 pounds.

Twenty-eight acres have been seeded to rye for next year's crop.

Alfalfa

Alfalfa was grown on 34 acres, the first cutting being 61½ per cent of the whole yield. Nineteen and one-half acres were cut three times, while the remaining 14½ acres were cut but twice; the severe August drought allowing but a meager growth, much of which became affected with "leaf spot" and was too short to be gathered with a horse rake. Eight acres constitute the new seeding to alfalfa. The cost of seeding the eight acres was 339½ man-hours, 613 horse-hours; an average of 42.4 man-hours and 76.6 horse-hours per acre.

Oats and Peas

Oats and peas occupied 23½ acres on the dairy and Wolpert farms. Most of the crop was cut green for silage, some fed as green forage and a small portion was cut for hay. Sixteen and one-half acres cut green yielded 162,220 pounds, equal to 9,832 pounds per acre. The customary wet weather of late July frequently causes much annoyance in curing the crop of oats and peas for hay, and it is probably a simpler, if not a cheaper process, to ensile the crop, besides getting the product off the land earlier and allowing more time to prepare a seed-bed for the succeeding crop. Oats and peas have fitted into our rotations here with increasing usefulness and, being a short-season crop, is capable of varying adaptability.

Timothy Hay

Timothy hay was grown on plots of old sod, aggregating 28 acres. One ton per acre of oyster-shell lime was applied to the 10-acre meadow, 1½ tons per acre to the 15-acre meadow and no lime to the 3-acre triangle field. The 15-acre meadow was manured last fall, it being a thin sod at that time, much fouled by weeds. The top-dressing in the spring for all hay meadows consisted of 150 pounds of nitrate of soda, 250 pounds of acid phosphate and 75 pounds of salt. The timothy and red-top on the 15-acre meadow responded to this treatment, crowded the weeds to a minor factor and cut more than 2½ tons of high-grade hay per acre. The exact weight from this field and the 10-acre field cannot be given because part of the hay from each remains in barrack and has not been weighed. The latter field probably cut 2¾ tons per acre. The triangle field of 3 acres cut 18,350 pounds of hay, equal to 3 tons, 117 pounds per acre.

Soybeans

Soybeans were planted in August on 16½ acres of oat-and-pea stubble, and where there was sufficient moisture to germinate the beans well a good catch crop for green manure resulted. Rye was planted on all of this ground, with no mineral nitrogen added, and the prospect of a good crop next year is promising.

Vertical Drainage

Vertical drainage may result in lowering the water-table under a portion of 35 acres of the dairy farm in need of underground drainage. In searching for porous strata, underlying the clay surface soil and impervious hard-pan, several holes were bored. Under several low spots no gravel was found in borings 12 feet deep; but in each of five places a porous stratum was found, which led us to "shoot" these particular spots with dynamite, at a point below the hard-pan, which latter was found at from 2 to 5 feet below the surface. Recent rains have demonstrated that all low spots, except the ones where the hard-pan was broken with dynamite, held water several days, while the water quickly disappeared from the depressions where dynamite had been used, indicating at least a partial benefit from vertical drainage.

Clearing "New Ground"

Clearing "new ground" is our most recent undertaking. To demonstrate the cost of clearing such land of stumps and brush, preparatory to breaking up virgin soil for field crops, which should be far more valuable than abandoned fields for increasing the nation's supply of cereals, a start has been made in that direction on one side of our 40-acre tract of "new ground." A combination of forces is being used on the stumps and brush clumps as the most economical method, stump-pullers being augmented by dynamite. No figures are yet available.

Wood

Wood from dead chestnut trees has been an asset of doubtful value to the College Farm for a long time. War conditions have created a demand for labor and kindling wood, which has become so acute that cord-wood of dead chestnut, in sound condition, will command a price nearly double that formerly given for higher grade mixed woods, and, although the cost of cutting the wood is nearly double the price per cord prevailing two years ago, the net price now exceeds the former gross price for cord-wood, and is 40 per cent of the selling price of high-grade oak saw logs.

REPORT OF THE DEPARTMENT OF SOIL CHEMISTRY AND BACTERIOLOGY

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Report of the Department of Soil Chemistry and Bacteriology

JACOB G. LIPMAN
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I

THE INFLUENCE OF THE MECHANICAL COMPOSITION OF THE SOIL ON THE AVAILABILITY OF NITRATE OF SODA AND DRIED BLOOD

This is a continuation of the work that was begun in the spring of 1911, the results having been published in the annual reports for the respective years since that time. The work has been carried out in cylinders of the type that has been in use at this Station for a number of years.[1] The soil used in the cylinders was the typical red shale that had not been under cultivation. After screening to remove the stones this was mixed with coarse white sand in varying proportions as indicated in the accompanying diagram. It will be noted that the cylinders are arranged in 10 groups or series of six each; Nos. 1 and 2 in each series receiving no fertilizer, these being the checks, Nos. 3 and 4 receiving 10 gm. of nitrate of soda, and Nos. 5 and 6 an equivalent amount of dried-blood nitrogen. The cylinders of Series A contain the shale soil, Series B the shale soil with 10 per cent of sand, and so on to Series J, which is entirely coarse white sand. Each cylinder receives annually 20 gm. of acid phosphate, 5 gm. each of potassium sulfate and potassium chloride, 38 gm. of precipitated chalk (or ground limestone) and 2 gm. of magnesium carbonate. Two crops have been grown each year: a main crop, barley, and a residual crop, usually buckwheat.

In this experiment it is desired to ascertain the relative availability of nitrogen from the two sources under the varying mechanical conditions.

[1]Voorhees, E. B., and Lipman, J. G., 1909. Investigations relative to the use of nitrogenous materials, 1898-1907. N. J. Agricultural Experiment Station, Bulletin 221.

First Crop—Barley, 1917

Following the buckwheat crop of 1916 and without any additional fertilizers, the cylinders were seeded to rye as a winter cover

Plan of Experiment

Series	Arrangement of Cylinders	Soil	Fertilizer Treatment
A...	1 2 3 / 4 5 6	Shale Soil	1, 2, Nothing. 3, 4, 10 gm. nitrate soda. 5, 6, 12 gm. dried blood.
B....	1 2 3 / 4 5 6	10% sand	"
C....	1 2 3 / 4 5 6	20% "	"
D....	1 2 3 / 4 5 6	30% "	"
E....	1 2 3 / 4 5 6	40% "	"
F....	1 2 3 / 4 5 6	50% "	"
G....	1 2 3 / 4 5 6	70% "	"
H....	1 2 3 / 4 5 6	80% "	"
I.....	1 2 3 / 4 5 6	90% "	"
J....	1 2 3 / 4 5 6	100% "	"

crop. This made a good start during the fall and by the middle of the following April the cylinders were fairly well covered with a

PLATE I.

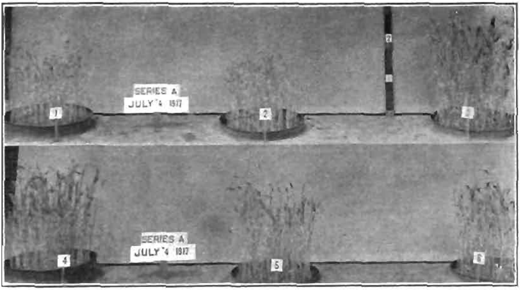

FIG. 1.—Series A, shale soil: 1 and 2, check; 3 and 4, nitrate of soda; 5 and 6, dried blood.

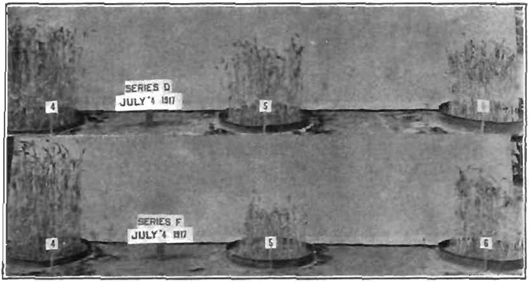

FIG. 2.—Series D, 30 per cent sand / Series F, 50 per cent sand — No. 4, nitrate of soda. / No. 5 and 6, dried blood.

(In applying the fertilizer 5-F was appauently missed. It should check with 6-F.)

PLATE II.

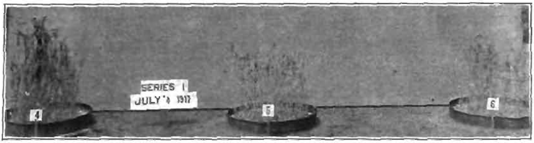

FIG. 1.—Series I: 90 per cent sand.

With 90 per cent sand nitrate of soda (No. 4) gave a much larger yield than dried blood (No. 5 and 6).

FIG. 2.—Soybeans do well with basic slag as a source of phosphorus. (See table 6 for treatments.)

growth varying from 2 to 5 inches in height. The poorest growth was on the cylinders that contain the coarse sand, and the best on those that contain the shale soil. The crop on some of the cylinders was slightly injured by winter-killing.

The cover crop was spaded under on April 17. A few days later the fertilizers were applied and 100 grains of beardless barley planted to each cylinder. The barley came up well and grew nicely throughout the season. Notes made on June 21 state that the barley on the nitrate cylinders was invariably larger—taller, with larger heads and broader leaves—than that on the check or dried-blood cylinders. At this time an irregularity was noticed in cylinder 5F. This cylinder receives its nitrogen as dried blood and the crop should compare favorably with the crop on 6F. It was, however, much smaller and the inference is that in applying the dried blood this cylinder was in some way missed. The difference between the crop on the two cylinders may be easily noted in the accompanying photograph. On account of this difference the results for 5F are omitted from the average.

The crop was harvested July 13 and samples prepared for analysis in the usual way. The results are set forth in table 1. As in previous years the check cylinders produced the least dry matter and the nitrate cylinders the most, the average for the entire series being 37.19 gm. for the check cylinders, 134.09 gm. for the nitrate cylinders, and 83.07 gm. for the dried-blood cylinders. The highest average yield with nitrate of soda was 159.8 gm. on Series B with 10 per cent of sand, and the next highest 154 gm. on Series F with 50 per cent of sand. It is of interest to note that with only a few exceptions the yields remain fairly constant up to and including Series F. With larger percentages of sand there is a gradual decrease in both the check cylinders and those that receive the nitrogenous fertilizers.

In most cases there is fair agreement between the duplicates. The average yields for the different treatments are shown by the curves in figure 1.

Percentage of Nitrogen in the Dry Matter

The percentage of nitrogen in the dry matter runs fairly uniform, the amount in the majority of cases being between 1.00 per cent and 1.2 per cent. It is of interest to note, however, that the average

Table I

Barley, 1917

Series		NITROGEN APPLIED GRAMS	Dry matter grams: Per cylinder	Dry matter grams: Average	Per cent nitrogen	Nitrogen grams: Per cylinder	Nitrogen grams: Average	Nitrogen increase over check grams	Per cent nitrogen recovered	Relative availability. Per cent
A. ...	1		78.9		1.106	0.873				
	2	Nothing....	60.7	69.8	1.027	0.623	0.748	....	....	....
	8		147.7		1.145	1.691				
	4	1.54....	151.7	149.7	1.076	1.632	1.652	0.914	59.35	100.00
	5		102.2		1.135	1.160				
	6	1.54....	103.4	102.8	9.997	1.031	1.096	0.348	22.59	38.05
B. ...	1		63.8		1.076	0.686				
	2	Nothing....	59.9	61.9	1.086	0.651	0.669	....	....	....
	3		149.1		0.968	1.443				
	4	1.54....	170.4	159.8	1.066	1.816	1.630	0.961	62.40	100.00
	5		117.9		1.066	1.257				
	6	1.54....	118.3	118.1	1.056	1.249	1.253	0.584	37.92	60.76
C. ...	1		40.0		1.106	0.442				
	2	Nothing....	52.4	46.2	1.007	0.528	0.485	....	....	....
	3		151.9		0.928	1.410				
	4	1.54....	151.5	151.7	0.958	1.451	1.431	0.946	61.42	100.00
	5		93.9		1.106	1.039				
	6	1.54....	85.6	89.8	1.086	0.930	0.985	0.500	32.46	52.84
D ...	1		32 4		1.224	0.397				
	2	Nothing....	44.1	38.3	1.116	0.492	0.445	....	....	....
	3		154.0		1.007	1.551				
	4	1.54....	150.9	162.5	0.987	1.489	1.520	1.075	69.80	100.00
	5		93.9		1.116	1.048				
	6	1.54....	101.1	97.5	1.096	1.108	1.078	0.633	41.10	58.88
E. ...	1		35.0		1.185	0.415				
	2	Nothing....	35.9	35.5	1.195	0.429	0.422	....	....	....
	3		135.9		1.076	1.462				
	4	1.54....	144.0	139.9	0.997	1.436	1.449	1.027	66.68	100.00
	5		90.4		1.108	1.000				
	6	1.54....	88.9	89.7	1.116	0.992	0.996	0.574	37.27	55.89
F. ...	1		33.4		1.224	0.409				
	2	Nothing....	34.4	33.9	1.214	0.418	0.414	....	....	....
	3		153.5		0.859	1.319				
	4	1.54....	154.4	154.0	0.918	1.417	1.368	0.954	61.94	100.00
	5		38.0*		1.135	0.431*				
	6	1.54....	89.2	89.2	0.997	0.888	0.889	0.475	30.84	49.79
G. ...	1		21.3		1.155	0.246				
	2	Nothing....	21.3	21.3	1.232	0.262	0.254	....	....	....
	3		132.8		0.918	1.219				
	4	1.54....	131.1	132.0	0.849	1.113	1.166	0.912	59.22	100.00
	5		60.9		1.106	0.674				
	6	1.54....	67.9	64.4	1.027	0.697	0.686	0.432	28.05	47.36
H ...	1		29.4		1.076	0.316				
	2	Nothing....	26.9	28.2	0.997	0.268	0.292	....	....	....
	3		132.4		1.007	1.333				
	4	1.54....	122.9	127.7	1.017	1.250	1.292	1.000	64.93	100.00
	5		71.4		1.047	0.748				
	6	1.54....	69.9	70.7	1.027	0.718	0.733	0.441	28.63	44.09

Barley, 1917

Table I—Continued

Series		NITROGEN APPLIED GRAMS	Dry matter grams: Per cylinder	Dry matter grams: Average	Per cent nitrogen	Nitrogen grams: Per cylinder	Nitrogen grams: Average	Nitrogen increase over check grams	Per cent nitrogen recovered	Relative availability. Per cent
I	1		17.7		1.027	0.182				
	2	Nothing....	24.9	21.3	1.047	0.261	0.222	....	....	....
	3		119.8		0.948	1.136				
	4	1.54....	116.7	118.3	0.977	1.140	1.138	0.916	59.48	100.00
	5		57.5		1.096	0.630				
	6	1.54....	62.4	60.0	1.056	0.659	0.645	0.423	27.46	46.18
J	1		5.9*		0.928	0.055*				
	2	Nothing....	15.5	15.5	1.106	0.171	0.171			
	3		70.1		1.461	1.024				
	4	1.54....	40.5	55.3	1.362	0.552	0.788	0.617	40.06	100.00
	5		55.2		1.116	0.616				
	6	1.54....	41.7	48.5	1.076	0.449	0.533	0.362	23.51	58.68
		Averages	....	37.19	1.1067	....	0.4122	....	....	....
			....	134.09	1.0262	....	1.3444	0.932	60.53	100.00
			....	83.07	1.0781	....	0.8894	0.477	30.98	51.26

*Omitted from average.

*for all the check cylinders slightly exceeds the average for the ni*trate and the dried blood cylinders.

This is in agreement with results reported last year and with other work previously reported. The stunted growth, due to a deficiency of nitrogen, gives a product slightly richer in nitrogen, but this concentration is secured at the expense of leaf and stem growth; that is, with a great reduction in total yield. It is another reminder that maximum crops cannot be produced when the nitrogen supply is deficient, even though the minerals are present in liberal amounts.

Total Nitrogen Recovered in the Crop

Since the percentage of nitrogen in the dry matter remains fairly constant, the amount of nitrogen which the crop returns must depend *largely* upon *the yield of dry matter, and inasmuch as the* nitrate cylinders gave the largest yield of dry matter it follows *that they will also give the* largest yield of nitrogen. This is true for all series. The largest average yield was 1.66 gm. from the

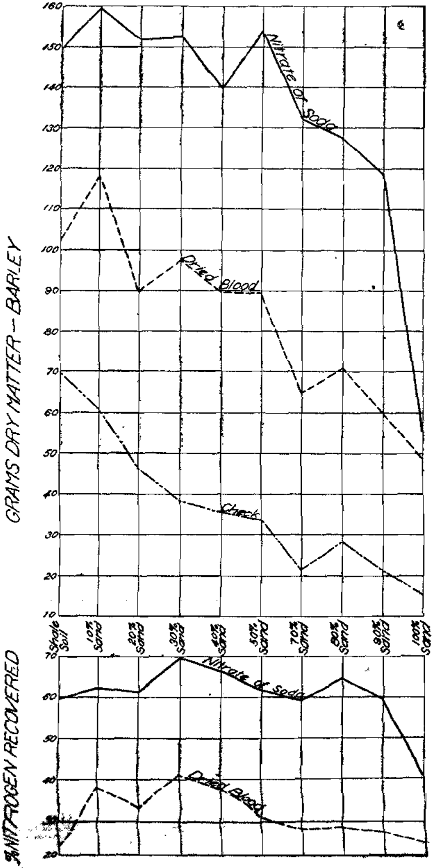

FIG. 1.—Weight of dry matter and percentage of nitrogen recovered in first crop: barley.

nitrate cylinders in Series A, and the next largest, 1.63 gm. from the same cylinders in Series B. The average for all the check cylinders was 0.41 gm., for the nitrate cylinders 1.34 gm., and for the dried-blood cylinders 0.89 gm. Thus the yield from the nitrate cylinders was more than three times as great as from the check cylinders and one and one-half times the amount from the dried-blood cylinders.

Percentage of Nitrogen Recovered

The amount of nitrogen recovered in the check cylinders of each series is taken as the amount which the *soil* can supply to the crop and therefore the difference between this and the total amount recovered from cylinders to which nitrogenous fertilizers have been applied should represent the amount of the applied nitrogen that was recovered. Given the amount of nitrogen applied and the amount recovered in the crop it is a simple calculation to find the percentage recovered.

This has been done for the ten series and in every one the percentage recovered from the nitrate exceeds that from the dried blood. The relation between the two materials is clearly shown in figure 1 (lower portion).

The highest recovery is 69.8 per cent from Series D, with 30 per cent of sand, and the next highest 66.68 per cent from Series E, with 40 per cent of sand. The lowest recoveries for both nitrate and blood are found in Series J, with coarse sand.

It is significant that in Series H and I with 80 and 90 per cent of sand, respectively, the recoveries should be 64.9 per cent and 59.5 per cent, respectively. It indicates that with an amount of available nitrogen which the plant can readily use the percentage loss from nitrate, in a sandy soil, is not much greater than it is in soils that are distinctly heavier. The highest recovery for dried blood is 41.1 per cent, also in Series D with 30 per cent of sand; and this series likewise gave the highest recovery from blood in 1916, the amount being 51.95 per cent.

The average recovery from nitrate for all series is 60.53 per cent, and from dried blood 30.98 per cent. The corresponding figures for

1916 were 60.64 per cent and 41.23 per cent. It will thus be observed that the recovery from nitrate is almost exactly the same for the two years, but that the recovery from blood is about 10 per cent less this year than last.

Residual Crop—Buckwheat, 1917

After harvesting the crop of barley the soil in the cylinders was spaded and on July 14 Japanese buckwheat was planted without further addition of fertilizers. A good stand was secured and growth during the season was fairly uniform, though there was in

GRAMS DRY MATTER
BUCKWHEAT

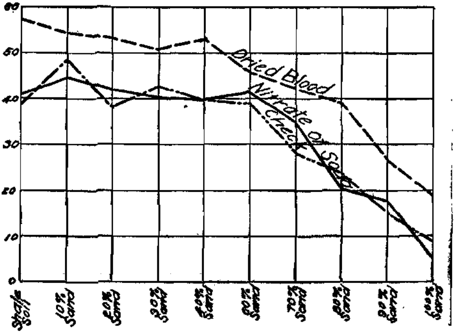

FIG. 2.—Weight of dry matter in residual crop.

nearly all the series a difference in favor of the dried blood. This is clearly brought out in the table and also in curves in figure 2. The results for the residual crop and also the combined results for the two crops are shown in table 2.

In the case of the residual crop the yields from the nitrogen-treated cylinders are notably lower than they were from the first crop, being only a little more than the yields from the check cylin-

ders. This shows how completely the first crop exhausted that part of the applied fertilizer which was not in some way lost.

The average yields are, on the other hand, considerably higher than for either 1915 or 1916, which would seem to indicate that the soils are not being depleted in fertility. The highest average yield was obtained with dried blood on Series A (shale soil) and the second highest on Series B (10 per cent sand). It is of especial interest to note that the cylinders which received the dried blood gave the highest average yield throughout the series, and this average is about 12 points above the averages for the nitrate of soda and check cylinders, again illustrating the fact that dried blood has a greater residual effect than nitrate of soda. This, however, should not cause one to overlook the fact that the initial effect of nitrate of soda is enough greater than that of dried blood to give a distinct advantage to the former when the results from the two crops are taken together. This is clearly brought out by the curves in figure 3, upper and lower portions.

Percentage of Nitrogen in the Dry Matter

The percentage of nitrogen in the dry matter does not appear to have been influenced to any extent by the different treatments, the averages being 1.33 per cent for the check cylinders, 1.39 per cent for the nitrate of soda cylinders and 1.33 per cent for the dried-blood cylinders. Neither is there a very wide variation in the different series until Series J is reached. The average for this series is distinctly higher than the average for any of the other series. The supply of nitrogen in these cylinders (100 per cent sand) is very limited and as previously pointed out, it would appear that plants thus dwarfed contain in their dry matter an exceptionally high percentage of this element.

Total Nitrogen Recovered

The average amount of nitrogen recovered from the check cylinders and dried blood cylinders is very nearly the same, the figures being 0.41 gm. and 0.43 gm., respectively. The average amount recovered from the dried blood cylinders is 0.57 gm. The highest average recovery is with dried blood on Series A, and the second highest also with dried blood on Series B.

It is of interest to note that the average amount of nitrogen recovered for the different treatments in Series E, with 40 per cent

Table 2

Residual Crop of Buckwheat, 1917. and Summary for Both Crops

Series		Nitrogen applied, grams	Buckwheat: Dry matter grams, Per cylinder	Buckwheat: Dry matter grams, Average	Buckwheat: Per cent nitrogen	Buckwheat: Nitrogen grams, Per cylinder	Buckwheat: Nitrogen grams, Average	Buckwheat: Nitrogen increase over check, grams	Buckwheat: Per cent nitrogen recovered	Summary for both crops: Total dry matter grams	Summary for both crops: Total nitrogen grams	Summary for both crops: Nitrogen increase over check grams	Summary for both crops: Per cent nitrogen recovered	Summary for both crops: Relative availability Per cent
A	1	No nitrogen applied to the residual crop.	37.0		1.270	.470								
	2		40.1	38.6	1.193	.478	.474	....	....	108.4	1.222	....	....	....
	3		48.9		1.339	.655								
	4		32.0	40.5	1.418	.454	.558	.081	5.26	190.2	2.217	0.995	64.61	100.00
	5		62.9		1.320	.829								
	6		51.5	57.2	1.270	.654	.742	.268	17.40	160.0	1.838	0.616	40.00	61.90
B	1		51.5		1.270	.654								
	2		45.5	48.5	1.231	.560	.607	....	....	110.4	1.276	....	....	....
	3		47.4		1.300	.616								
	4		41.5	44.5	1.487	.617	.617	.010	0.65	204.3	2.247	0.971	63.05	100.00
	5		56.3		1.339	.754								
	6		52.5	54.4	1.310	.688	.721	.114	7.40	172.5	1.974	0.698	45.32	71.87
C	1		41.2		1.270	.523								
	2		34.9	38.1	1.270	.443	.483	....	....	84.3	0.968	....	....	....
	3		40.3		1.398	.563								
	4		43.4	41.9	1.320	.573	.568	.085	5.51	193.6	2.003	1.035	67.20	100.00
	5		53.5		1.310	.701								
	6		53.0	53.3	1.329	.604	.653	.170	11.04	143.1	1.638	0.670	43.50	64.73
D	1		43.0		1.241	.534								
	2		42.1	42.6	1.251	.527	.531	....	....	80.9	0.976	....	....	....
	3		37.5		1.280	.480								
	4		42.9	40:2	1.251	.537	.509	....	....	192.7	2.029	1.053	68.37	100.00
	5		53.0		1.221	.647								
	6		48.8	50.9	1.310	.639	.643	.112	7.27	148.4	1.721	0.745	48.37	70.74

NO NITROGEN APPLIED TO THE RESIDUAL CROP.

E	1	39.5		1.231	.485							
	2	39.8	39.7	1.211	.482	.484	....	....	76.2	0.906	....	....	....
	3	38.6		1.270	.489							
	4	40.9	39.7	1.241	.508	.499	.015	0.97	179.5	1.948	1.042	67.66	100.00
	5	58.0		1.270	.673							
	6	53.0	53.0	1.221	.647	.660	.176	11.42	142.7	1.656	0.750	48.70	71.97
F	1	37.1		1.241	.460							
	2	40.5	38.8	1.162	.471	.466	....	....	72.7	0.880	....	....	....
	3	38.0		1.290	.490							
	4	44.8	41.4	1.251	.560	.525	.059	3.82	195.4	1.893	1.013	65.77	100.00
	5	42.9		1.192	.511							
	6	48.6	45.8	1.211	.589	.550	.084	5.46	109.4	1.439	0.330	36.30	55.19
G	1	25.3		1.241	.313							
	2	31.0	28.1	1.162	.360	.337	....	....	49.4	0.591	....	....	....
	3	34.1		1.251	.427							
	4	35.8	35.0	1.172	.420	.424	.087	5.64	167.0	1.590	0.999	64.87	100.00
	5	46.0		1.261	.580							
	6	38.8	42.4	1.261	.489	.535	.198	12.82	106.8	1.221	0.630	40.90	63.05
H	1	30.0		1.261	.328							
	2	21.5	23.8	1.241	.267	.298	....	....	52.0	0.590	....	....	....
	3	18.5		1.418	.262							
	4	22.0	20.3	1.290	.284	.273	....	....	148.0	1.565	0.975	63.31	100.00
	5	42.5		1.211	.515							
	6	35.9	39.2	1.280	.460	.488	.190	12.33	109.9	1.221	0.631	40.97	64.71
I	1	12.5		1.428	.179							
	2	17.6	15.1	1.369	.244	.212	....	....	36.4	0.434	....	....	....
	3	17.7		1.438	.255							
	4	18.0	17.9	1.428	.257	.256	.044	2.85	136.2	1.394	0.960	62.33	100.00
	5	27.0		1.310	.354							
	6	26.8	26.9	1.270	.340	.347	.136	8.76	86.9	0.992	0.558	36.23	58.12
J	1	4.7		1.891	.089							
	2	12.8	8.8	2.117	.271	.180	....	....	19.5	.351	....	....	....
	3	5.2		2.078	.108							
	4	6.0	5.6	1.842	.111	.110	....	....	60.9	0.898	.547	35.52	100.00
	5	20.5		1.684	.345							
	6	18.0	19.3	2.107	.379	.362	.182	11.81	67.8	0.895	.544	35.33	99.45
Averages		....	32.21	1.329	....	.407	....	....	83.92	0.819	....	....	....
		....	32.70	1.388	....	.434	....	2.47	166.79	1.778	0.959	62.27	100.00
		....	44.24	1.334	....	.570	....	10.57	124.75	1.460	0.617	41.56	68.17

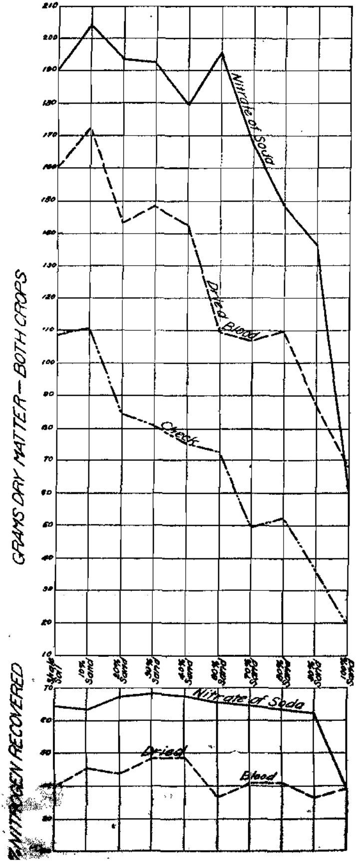

FIG. 3.—Weight of dry matter and percentage of nitrogen recovered: both crops.

of sand, is about as much as the average amount in Series A with shale soil. This confirms Hilgard's[2] observation to the effect that in a sandy soil the roots penetrate to a greater depth and have within their reach a much larger soil mass than in a clay soil where the root range is restricted, with the result that the plant does equally well with correspondingly smaller percentages of plant-food.

Percentage of Nitrogen Recovered

As has already been intimated the recovery of nitrogen from the nitrate of soda cylinders was small, the highest being 5.64 per cent in Series G. In three of the series there was no recovery. The lowest recovery from dried blood was almost as great as the highest form nitrate of soda. The average for all series with the nitrate of soda was 2.47 per cent and the corresponding average for dried blood was 10.57 per cent.

The Combined Crops

The average total yield of dry matter for all series was: for the check cylinders 68.9 gm.; for the nitrate of soda cylinders 166.8 gm., and for the dried blood cylinders 124.8 gm. Series B with 10 per cent of sand gave the highest total yield of dry matter and likewise of nitrogen for each of the three treatments. The average recovery of nitrogen for all series is, for nitrate of soda 62.27 per cent, and for dried blood 41.56 per cent. These figures agree quite closely with results secured in previous years, and also confirm results reported by European investigators.

That the recovery from the nitrate of soda was very uniform, even with the higher percentages of sand, is shown by the fact that with the exception of Series J, the amount did not fall below 60 per cent. Likewise the recovery from the dried blood was quite uniform, only three series falling below 40 per cent, with an average of 41.56 per cent. In the pure sand the recovery was practically the same from the nitrate and dried blood.

If 100 is taken as the availability of nitrate nitrogen for all series, then the average relative availability for dried blood will be 68.17 It will be noted that the availability of dried-blood nitrogen in the sand, Series J, is essentially the same as that of the nitrate nitrogen.

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[2]Hilgard, E. W., 1906, Soils, p. 347, The MacMillian Co., New York.

Theoretical and Actual Recoveries from the Shale Soil

A comparison of the amount of nitrogen which should be recovered from the organic matter of the shale soil where sand constituted a part of the mixture (as calculated from the recovery in pure shale), with the net amount actually recovered, is of interest. By referring to the combined results in table 2 under "Total Nitrogen," it will be seen that there was recovered from the check cylinders of Series A 1.222 gm. of nitrogen. From the corresponding cylinders with pure sand there was a recovery of 0.351 gm. of nitrogen made up of traces which may have been in the sand and water, that which was in the seed, and any which may have been *fixed by non-symbiotic organisms. The difference between these* two amounts—0.871 gm.—represents the actual net recovery from the shale soil cylinders, Series A. Since the check cylinders of Series B were 90 per cent shale instead of straight shale, the theoretical recovery from these should be 90 per cent of 0.871 gm., which is 0.784 gm. The *actual* amount of nitrogen recovered in the combined crops from the check cylinders of Series B was 1.276 gm., and subtracting from this the 0.351 gm. (combined recovery from the check cylinders in straight sand) we have 0.925 gm., which represents the net recovery from the shale soil of Series B.

Table 3

Nitrogen Recovered from Shale Soil—Combined Crops

Series	COMPOSITION OF THE SOIL	Theoretical amount of nitrogen recovered, gram	Actual amount of nitrogen recovered, gram
A	100% Shale Soil	.871	.871
B	90% " "	.784	.925
C	80% " "	.697	.817
D	70% " "	.610	.626
E	60% " "	.523	.555
F	50% " "	.436	.629
G	30% " "	.261	.340
H	20% " "	.174	.239
I	10% " "	.087	.092
J	100% Sand	....	....

In the same way may be calculated the theoretical and actual recoveries from the humus of the shale soil for all the various dilutions. These results are shown in table 3.

With slight exception, the actual recoveries equal or exceed the theoretical as calculated from the recovery with shale soil alone.

Summary

This is a report of work, begun in 1911, on the availability of nitrate of soda and dried blood when used on shale soil and on mixtures of sand and shale soil.

1. Two crops were grown, but the fertilizers were all applied at the time of the planting of the first crop of barley.

2. For all the soil combinations the yield of barley was higher with nitrate of soda than with dried blood. The average yields were: nitrate of soda 134.1 gm.; dried blood 83.07 gm., and check cylinders 37.2 gm.

3. For the barley, the average recovery of nitrogen from nitrate of soda was 60.53 per cent and the average from dried blood 30.98 per cent. The highest recovery from the nitrate was 69.8 per cent, and the highest from dried blood 41.1 per cent.

4. Assuming an availability of 100 for nitrate nitrogen throughout the series, dried blood nitrogen, on the same basis, would have an availability of 51.25.

5. For the second crop—buckwheat—the dried blood cylinders gave the highest yield for all soil combinations. The average yield from the nitrate cylinders and the check cylinders was practically the same. It is thus evident that but little of the nitrate remained for the second crop. The average recovery for this crop was 2.47 per cent from the nitrate cylinders, and 10.57 per cent for the dried blood cylinders.

6. Although with the second crop, the dried blood cylinders gave a higher recovery than the nitrate cylinders, when the combined recoveries are considered, it is found that the nitrate stands first in all series, the averages being 62.27 per cent for the nitrate and 41.56 per cent for the blood. For the combined crops, dried blood shows an availability of 68.2 on the basis of 100 for the nitrate.

7. From these results and likewise from the results secured for a period of years, it is quite clear that nitrate of soda cannot be counted on to show much residual effect. Dried blood, on the other hand, does show some residual effect on both heavy and light soils. However, the initial effect of the nitrate is almost always sufficiently above that of the blood to place the former in first rank when the

combined crops—that is, the first crop and the residual crop—are taken into consideration.

8. A pound of nitrate nitrogen produces more dry matter than a pound of dried blood nitrogen, and therefore, in most cases, is worth more.

9. The nitrogen of the soil organic matter is more completely utilized in a light soil than it is in the heavier types.

THE CONTINUOUS GROWING OF WHEAT AND RYE WITH AND WITHOUT A LEGUME AS GREEN MANURE, 1917

The plan of this experiment was described in the annual report for 1912, where the results for the first five years were given in detail.[8] Further accounts have appeared in the annual reports for 1913, 1914, 1915 and 1916. For convenience the general plan may be briefly restated.

Plan of Experiment

For a number of years the Experiment Station has been conducting experiments to determine to what extent the nitrogen supply of the soil may be maintained by the growing of leguminous crops between the main crops of the rotation. One of these experiments is the continuous growing of wheat and rye with and without a leguminous crop as a source of nitrogen. It is not maintained that it is profitable or advisable to grow these two crops continuously without rotation, but it seemed desirable to determine whether it is possible to grow them thus, and what would be the effect of such practice upon the chemical and physical composition of the soil.

The soil on which this experiment is being carried out is a sandy loam, and prior to starting the work in 1908 was in a poor state of cultivation. The plots are 1/20 acre in size and are designated as Nos. 68, 69, 70 and 71; Nos. 68 and 70 being the rye plots and Nos. 69 and 71 the wheat plots. Each year immediately following the

[8]Lipman, J. G., et al. 1912. Report of the soil chemist and bacteriologist. In N. J. Agr. Exp. Sta., 33rd Annual Rpt. (1912), p. 261.

cutting of the grain, Nos. 70 and 71 are disked and seeded to soybeans (cowpeas for the first four years) and these are allowed to grow until about two weeks before the time for again seeding to wheat and rye, when they are turned under as a green manure crop. The other two plots, 68 and 69, are left in stubble during the time that the leguminous crop is growing and are plowed when the cover crop on Nos. 70 and 71 is turned under.

Crop of 1917

On July 14, 1916, plots 70 and 71 were double-disked and seeded, broadcast, to Ito San soybeans. These came up well and made a good growth, being 20 to 22 inches high with pods well set on September 21, when they were plowed under for the fall seeding of the wheat and rye. Determinations made on samples cut from 1 square yard show that there were 2,662 pounds of dry matter on plot 70, and 3388 pounds on plot 71, roots not included. Since soybeans harvested at this stage contain, in the dry matter, about 3 per cent of nitrogen, this means that about 80 to 100 pounds of nitrogen, in addition to that contained in the roots, was put into the soil with the turning under of this crop. It does not necessarily mean that all this nitrogen came directly from the air, but it seems fair to assume that a good proportion of it came from that source, for the roots were abundantly supplied with nodules, showing good inoculation. Thus in about 60 days, and without in any way interfering with the main crop, an excellent green manure crop was produced. While the beans were growing on plots 70 and 71, plots 68 and 69 remained in stubble, and during this time a good deal of volunteer red and white clover appeared on these plots. In this way a considerable amount of nitrogen is added to these plots and this necessarily complicates the results, in that it tends to make the effect of the soybeans on plots 70 and 71 appear less than it really is. This tendency of volunteer clover to appear where the supply of minerals is well kept up has been noted elsewhere.[4]

About the last of September the fertilizers were applied and the wheat and rye seeded in the usual way. A fairly uniform stand of

[4]Lipman, J. G., and Blair A. W., 1913. Field experiments on the availability of nitrogenous fertilizers. N. J. Agr. Exp. Sta. Bulletin 260.
Blair, A. W., and McLean, H. C., 1917. Total nitrogen and carbon in cultivated land and land abandoned to weeds. In Soil, Sci., V. 4, No. 4, p. 283-293.

both wheat and rye was secured, but notes made November 1 state that the wheat was rather thin. On July 17 the wheat and rye were harvested, and samples were dried and prepared for analysis. The results of the work are shown in table 4.

Table 4

Rye and Wheat with and without a Legume Crop, 1917 (1-20 Acre Plots)

	CROP	GRAIN PER PLOT			STRAW PER PLOT			YIELD PER ACRE		
		Dry matter, pounds	Per cent nitrogen	Nitrogen, pounds	Dry matter, pounds	Per cent nitrogen	Nitrogen, pounds	Grain bushels	Straw, pounds	Total nitrogen pounds
68	Rye alone	41	2.048	.840	86	.473	.407	13.67	1720	24.94
69	Wheat alone	22	2.304	.507	39	.552	.215	7.33	780	14.44
70	Rye followed by soybeans	43	2.235	.961	138	.561	.774	14.33	2760	34.70
71	Wheat followed by soybeans ...	37	2.511	.929	71	.719	.510	12.33	1420	26.78

The yields this year are unusually low. This is no doubt due in part to the thin stand and in part to a deficiency of available nitrogen. The yield of rye on plot 70 is lower than it should be, as the sample was partly destroyed by rats. Notwithstanding the fact that the yield of wheat is low it is a satisfaction to report 5 bushels more from plot 71 than from 69, while the amount of straw from 71 is almost double that from 69. This increase must undobtedly be attributed to the soybeans that were grown on plot 71. In this connection it is worth while to point out also that just twice as much nitrogen was recovered from plot 71 as from 69. Without exception, both the wheat and the rye—grain and straw—grown after soybeans show a higher percentage of nitrogen than when grown alone. This means a food material higher in protein, and if such additional protein equivalent is taken from the air rather than from purchased fertilizers, it represents clear gain.

VEGETATION EXPERIMENTS ON THE AVAILABILITY OF PHOSPHOROUS AND POTASSIUM COMPOUNDS

Comparison of Basic Slags with other Phosphates

This is a continuation of the work that was begun in cooperation with the Basic Slag Committee of the Association of Official Agricultural Chemists in 1913[5].

It has not been possible to conduct the work on a field scale, as suggested by the committee, but the pot experiments have given results that are considered of sufficient value to be placed on record.

Results for 1916

The experiment was carried out in earthen-ware pots holding 11 pounds of white sand. The general treatment given to all pots consisted of:

1.0 gm. nitrate of soda
1.0 gm. potassium sulfate
0.5 gm. magnesium sulfate
0.25 gm. ferric sulfate
5.0 finely-ground limestone

The special treatment with the phosphate materials is indicated in the table of results. On July 24 Guelph soybeans were planted in each pot and the soil was inoculated by sprinkling with an infusion made with soil taken from land where soybeans were growing. The beans came up well and grew nicely during the summer. They were harvested October 4 when the pods were fairly well filled, but not mature, and samples were dried, weighed and prepared for analysis. The special treatment given and the results secured are indicated in table 5. Four pots, Nos. 1, 2, 27, and 28, received no phosphate and these are designated as the check pots. The average yield from these four pots was 14.95 gm. The difference between this and the average yield from the treated pots gives the increase due to the treatment. With the exception of the sodium phosphate all treatments resulted in some increase. Apparently the sodium phosphate had an injurious effect upon the plants. Such injury has been noted in earlier work.[5]

[5]Lipman, J. G., et al. 1913. Report of the soil chemist and bacteriologist. In N. J. Agr. Exp. Sta. 34th Annual Report (1913), p. 481-484.

Table 5

Comparison of Basic Slag with other Phosphates; Soybeans, 1916

Pot No.	Special Treatment	Dry Matter, Grams: Per pot	Dry Matter, Grams: Average	Dry Matter, Grams: Increase over check	Per cent nitrogen	Nitrogen, Grams: Per pot	Nitrogen, Grams: Average	Nitrogen, Grams: Increase over check
1		15.0			1.944	0.2916		
2	No. Phosphate	11.8	14.95		2.009	0.2371	.3063	
27		15.0			2.065	0.3098		
28		18.0			2.149	0.3868		
3		28.6			3.758	1.0748		
4	2.000 gm. acid phosphate.....17.82% P_2O_5	21.3	24.95	10.00	3.126	0.6658	.8703	.5640
5		10.0			3.051	0.3051		
6	1.707 gm. sodium phosphate.....20.87% P_2O_5	1.7†	10.00	....	3.368	0.0573†	.3051	....
7		29.7			3.116	0.9254		
8	1.945 gm. basic slag E.....18.33% P_2O_5	24.0	26.85	11.90	2.884	0.6922	.8088	.5052
9		29.8			2.707	0.8067		
10	1.947 gm. basic slag A.....18.30% P_2O_5	24.7	27.25	12.30	2.586	0.6387	.7227	.4164
11		28.9			2.884	0.8334		
12	1.870 gm. basic slag B.....19.04% P_2O_5	24.0	26.45	11.50	2.809	0.6742	.7538	.4475
13		28.7			3.265	0.9371		
14	2.677 gm. basic slag C.....13.31% P_2O_5	21.9	25.30	10.35	2.977	0.6520	.7946	.4883
15		28.5			3.098	0.8829		
16	2.247 gm. basic slag D.....15.86% P_2O_5	23.7	26.10	11.15	2.819	0.6681	.7755	.4692
17		31.0			3.302	1.0236		
18	3.890 gm. basic slag E.....18.33% P_2O_5	26.2	28.60	13.65	3.014	0.7897	.9067	.6004
19		15.7			2.158	0.3387		
20	2.425 gm. blue rock phosphate.....24.90% P_2O_5	18.5	17.10	2.15	1.944	0.3596	.3492	.0429
21		30.6			3.377	1.0334		
22	0.775 gm. double super-phosphate.....46.02% P_2O_5	24.8	27.70	12.75	3.406	0.8444	.9389	.6326
23		20.5			2.065	0.4234		
24	1.188 gm. Daybreak phosphate.....29.75% P_2O_5	19.7	20.10	5.15	1.972	0.3884	.4059	.0996
25		19.9			1.935	0.3851		
26	2.376 gm. Daybreak phosphate.....29.75% P_2O_5	19.1	19.50	4.55	1.944	0.3713	.3782	.0719

†Omitted from average.

The average increase over the check for the different materials was as follows:

Acid phosphate	10.00 gm.
Basic slag	10.64 gm.
Blue rock phosphate	2.15 gm.
Double super-phosphate	12.75 gm.
Daybreak phosphate	4.85 gm.

From these figures it would appear that the slags were more effective than the acid phosphate, and almost as effective as the double super-phosphate. The gain with the Daybreak phosphate is not so great as with the slags, but larger than with the blue rock phosphates. Of the slags the one designated as E[6] gave the largest increase.

It is of interest to note that the percentage of nitrogen in the dry matter from the untreated pots and the pots that received the rock phosphate is distinctly lower than it is in the dry matter from pots treated with basic slag and with soluble phosphates.

The averages are as follows:

Check pots (no phosphate)	2.04 per cent nitrogen
Acid phosphate	3.44 per cent nitrogen
Basic slag	2.91 per cent nitrogen
Blue rock phosphate	2.05 per cent nitrogen
Double super-phosphate	3.39 per cent nitrogen
Daybreak phosphate	1.98 per cent nitrogen

Thus it appears that where acid phosphate, double super phosphate and basic slag were used, there is about 1 to 1.4 per cent more nitrogen in the dry matter than where no phosphate was used, or where the raw rock phosphate was used. For a 2-ton crop, which is a fair yield for an acre, this would mean an increase of 40 to 56 pounds of nitrogen over the check, or 80 to 112 pounds if the yield was as much as 4 tons per acre. There is good reason to believe that this additional nitrogen is derived directly from the air and represents a gain due to the presence, in the soil, of the soluble phosphates. Certainly much more nitrogen was accumulated in the pots to which soluble phosphates were added than in those that received no phosphates or only the raw

[6]Slag E is an American product prepared at Birmingham, Ala. The other slags were furnished by the Basic Slag Committee, the source not being stated.

rock. This is shown by the following figures, which give the increase, over the check, for the various treatments:

Acid phosphate	.564 gm. nitrogen
Basic slag	.487 gm. nitrogen
Double super-phosphate	.633 gm. nitrogen
Blue rock phosphate	.043 gm. nitrogen
Daybreak phosphate	.086 gm. nitrogen

It will be noted that the highest average increase—0.633 gm.—was made by the double super-phosphate and the next highest—0.60 gm.—by basic slag E.

The average yield of dry matter on the basic slag pots calculated to the acre basis amounts to 6722 pounds per acre. Since this dry matter contains, on the average, 2.91 per cent of nitrogen, the yield of nitrogen would be at the rate of 195.6 pounds per acre.

The average yield of dry matter on the check pots calculated to the acre basis amounts to 3753 pounds. This contains an average of 2.04 per cent of nitrogen, or 76.6 pounds per acre. The increase over the check for the basic slag is therefore at the rate of 119 pounds per acre. Large increases are shown for the acid phosphate and the double super-phosphate. It must be remembered, however, that these yields are secured under optimum moisture conditions and with the exception of the check pots, an abundant application of fertilizers. Such yields could hardly be expected in the field on a sandy soil.

Results for 1917

The general plan of the experiment was the same as for 1916. However, a double quantity of the phosphate materials was applied with the idea of growing a second crop. Also, 2 gm. of KCl instead of 1 gm., and 10 gm. of limstone instead of 5 gm. were applied.

The pots were seeded to Guelph soybeans on May 29 and were inoculated with soil infusion. The beans made a good growth, good inoculation being evident both from the color and from the nodules found on the roots. They were harvested about 70 days from the time of planting. At this time the leaves were beginning to fall and the pods were fairly but not completely developed. The phosphate treatments and analytical data are given in table 6.

Table 6

Comparison of Basic Slag with other Phosphates; Soybeans, 1917

Pot No.	SPECIAL TREATMENT	DRY MATTER, GRAMS			Per cent nitrogen	NITROGEN, GRAMS		
		Per pot	Average	Increase over check		Per pot	Average	Increase over check
1	Check (no phosphate)	24.7	24.25		1.6445	0.4062	0.4024	....
2		24.5			1.5953	0.3909		
23		21.0			1.6839	0.3536		
24		26.8			1.7136	0.4592		
3		40.7			2.4126	0.9819		
4	4 gms. acid phosphate ... 17.82% P_2O_5	61.7	51.2	26.95	2.8065	1.7316	1.3568	.9544
5		31.2			2.0286	0.6329		
6	3.415 gm. sodium phosphate ... 20.87% P_2O_5	41.5	36.35	12.10	2.3831	0.9890	0.8110	.4086
7		38.5			2.0187	0.7772		
8	3.895 gm. basic slag A ... 18.30% P_2O_5	28.6	33.55	9.30	2.9444	0.8421	0.8097	.4073
9		49.7			1.9597	0.9740		
10	3.740 gm. basic slag B ... 19.04% P_2O_5	54.9	52.30	28.05	2.3240	1.2759	1.1250	.7226
11		36.3			2.1172	0.7685		
12	5.355 gm. basic slag C ... 13.31% P_2O_5	45.4	40.85	16.60	2.5407	1.1536	0.9610	.5586
13		60.5			2.1172	1.0692		
14	4.494 gm. basic slag D ... 15.86% P_2O_5	51.1	50.8	26.55	2.2846	1.1674	1.1183	.7159
15		46.8			2.1369	1.0001		
16	3.890 gm. basic slag E ... 18.33% P_2O_5	53.5	50.15	25.90	2.5899	1.3856	1.1929	.7905
17		21.8			1.7135	0.3735		
18	4.849 gm. blue rock phosphate ... 24.90% P_2O_5	35.0	28.40	4.15	1.7036	0.5963	0.4849	.0825
19		35.0			2.2649	0.7927		
20	1.549 gm. double super-phosphate ... 46.02% P_2O_5	44.5	39.75	15.50	2.6391	1.1744	0.9836	.5812
21		47.3			1.7726	0.8384		
22	2.376 gm. Daybreak phosphate ... 29.75% P_2O_5	33.5	40.40	16.15	1.7135	0.5740	0.7062	.3038

Attention may be called to the good agreement in dry weights from the four check pots. Unfortunately, the agreement is not so good in the weights, from the two acid phosphate pots. No reason appears for the low yield with slag A. Notes made June 13 refer to the fact that plants in pots 5 and 6 were inferior to the others. This may have been due to injury caused by the sodium phosphate, which has been mentioned in previous reports.

The average increase in yield for the different treatments over the average yield for the check pots is as follows:

Acid phosphate	26.95 gm.
Sodium phosphate	12.10 gm.
Basic slag	21.28 gm.
Blue rock phosphate	4.15 gm.
Double super-phosphate	15.50 gm.
Daybreak phosphate	16.15 gm.

Again the slags have made an excellent showing as compared with the acid phosphate. The blue rock phosphate is plainly less available than the Daybreak phosphate.

A point of especial interest is the low percentage of nitrogen in the samples from the check pots and those that received the unavailable phosphates, as compared with the available phosphates. This difference was noted in the work reported in the results for 1916 (p. 355), but the average percentage of nitrogen was higher for all treatments in that experiment than in the one here under consideration.

The averages for the different treatments are as follows:

Check	1.66 per cent nitrogen
Acid phosphate	2.61 per cent nitrogen
Basic slag	2.30 per cent nitrogen
Blue rock phosphate	1.71 per cent nitrogen
Sodium phosphate	2.21 per cent nitrogen
Double super-phosphate	2.45 per cent nitrogen
Daybreak phosphate	1.74 per cent nitrogen

It is very apparent that it was by no accident that the dry matter from the check pots and the pots that received the unavailable phosphates yielded from 0.5 to 1 per cent less nitrogen than the dry matter from the pots that received the more readily-available phosphates. A consideration of the increase in the yield of total nitrogen from the treated pots over that from the check pots shows an increase of nearly 1 gm. for the acid phosphate and an average of

0.642 gm. for all the available phosphate materials, including the slags. The average for the blue rock phosphate is only 0.08 gm. and for the Daybreak phosphate 0.30 gm.

Taking the surface area of the pots and calculating to the acre basis it is found that the average increase made by the pots that were treated with the available phosphates is equivalent to 161 pounds of nitrogen.

As previously pointed out, such an increase could hardly be expected under field conditions, because the moisture conditions would not be so favorable and also because normal soils would furnish more phosphorus than the sand in which these plants were grown. The work does, however, indicate in a striking manner the influence which soluble phosphates have on the accumulation of nitrogen by means of this crop.

Greensand Marl as a Source of Potash

The splendid success that followed the use of greensand marl on many farms in certain sections of New Jersey in the 70's and 80's,[7] coupled with the fact that potash salts are no longer to be had at a reasonable price, seemed to be reason enough to justify the trying out of greensand marl with different crops in pot experiments.

Experiment 1

The first work was carried out in glazed earthen-ware pots holding 20 pounds of coarse white sand.

This sand was taken from a pit where building sand was obtained and was as pure as could be secured without washing. It therefore contained only very small quantities of available plant-food. The general fertilizer treatment for each pot was as follows:

2	gm. ammonium sulfate
4	gm. acid phosphate
10	gm. pulverized limestone
0.5	gm. magnesium sulfate
0.25	gm. ferric sulfate

The special potash treatment is indicated in the accompanying tables.

[7]Annual Report N. J. State Geologist, 1886, p. 205-210.

Three different crops were grown simultaneously with the same special treatment, the crops being barley, soybeans and buckwheat. Two of these, barley and buckwheat, were followed immediately by a residual crop of soybeans without any further fertilizer treatment. These were harvested as forage. The main crop of soybeans was allowed to mature and the seed and stalks were saved separately. During the growing season water was applied to the pots at intervals in such amount as to keep the soil at as nearly a uniform percentage of moisture as possible. As the crops were harvested the samples were dried and weighed. The results are recorded in tables 7 and 8.

Considering first the soybeans in table 7, it will be noted that the marl-treated pots gave a larger yield of seed than the check pots, and also a slightly higher yield of stalks, the highest yield in each case being from those pots that received the marl and lime (calcium oxide).

The percentage of potash in the seed and stalks from the check pots is almost as high as it is in seed and stalks from marl-treated pots. That is, the plants in the check pots secured, in proportion to the yield, about as much potash as the marl-treated plants, but on account of a deficiency of available potash the yield of beans was depressed. On the other hand, the yield of stalks on the check pots was but little less than on the marl-treated pots. From this it would appear that the soybean plant is able to use potash from sources that are generally considered unavailable, and that the deficiency of available potash is not much felt until the beans are maturing. The results secured from the residual crop of soybeans, which is discussed later, lend emphasis to this view.

A consideration of table 8 shows that both the barley and buckwheat responded to the marl treatment, though the barley in pots 5 and 6 was injured by an excess of caustic lime. The buckwheat, on the contrary, seems to have been benefited by the lime, for on these pots the largest yield was obtained. The calcium sulfate which was used with the marl does not appear to have had much effect upon its availability. Following the barley, soybeans were seeded in the pots without further addition of fertilizers. The soil in the pots was inoculated by sprinkling with a soil infusion. Inoculation was successful and the beans made a fair growth. They were harvested as forage when the

pods were about half filled. The dry weights are shown in table 8. Here, as in the case of the stalks in the previous experiment, there is little difference between the yield on the check pots and the marl-treated pots. This seems to furnish further proof of the

Table 7

Greensand Marl as a Source of Potash-Soybeans

Pot Number	SPECIAL TREATMENT	SEED			STALKS		
		Dry matter grams		Per Cent Potash	Dry matter grams		Per Cent Potash
		Per Pot	Average		Per Pot	Average	
1		2.5		1.43	24.2		.59
2	Check	2.2	2.35	1.84	25.0	24.60	.61
3		3.4		1.90	22.5		.60
4	10 gm. marl	1.2*	3.40	1.80	33.7	28.10	.77
5		6.2		1.55	32.5		.64
6	10 gm. marl + 5 gm. CaO	5.3	5.75	1.85	29.0	30.75	.63
7		2.9		1.87	24.7		.45
8	10 gm. marl + 5 gm. $CaSO_4$	3.7	3.30	1.90	29.5	27.10	.44

*Omitted from average.

Table 8

Greensand Marl as a Source of Potash: Barley, Buckwheat; Residual Crops—Soybeans, Cowpeas

Pot Number	SPECIAL TREATMENT	Barley		Buckwheat		Residual Crop Soybeans		Residual Crop Cowpeas	
		Dry matter grams		Dry matter grams		Dry matter grams		Dry matter grams	
		Per Pot	Average	Per Pot	Average	Per Pot	Average	Per Pot	Average
1		0.0		1.2		25.9		16.3	
2	Check	0.0	0.0	1.0	1.10	27.0	26.45	12.0	14.15
3		7.0		9.8		28.8		9.1	
4	10 gm. marl	8.2	7.6	9.5	9.65	19.0	23.90	11.4	10.25
5		1.0		15.0		30.0		6.0	
6	10 gm. marl + 5 gm. CaO	1.0	1.0	15.9	15.45	27.1	28.55	6.5	6.25
7		11.9		8.2		24.3		10.9	
8	10 gm. marl + 5 gm. $CaSO_4$	11.1	11.5	13.0	10.60	21.0	22.65	9.1	10.00

ease with which this plant gets its potash from slowly available sources up to the time the beans are forming and maturing. Attention may here be called to the fact that the combination of marl and quick lime gave the largest yield, whereas this combination was almost fatal to barley.

Cowpeas followed the buckwheat in the same way that the soybeans followed the barley. The yield of cowpeas was not so large as the yield of soybeans, but the results are very much the same. One exception, however, may be noted, namely, a depressed yield where the caustic lime was used instead of an increase as occurred with the soybeans.

Experiment 2

The second experiment was carried out in very much the same way as the first. The material used in the pots, however, was a reddish brown coarse sand which contained 0.03 per cent nitrogen and 1.09 per cent of total potash. The general fertilizer treatment was as follows:

2 gm. ammonium sulfate
4 gm. acid phosphate
10 gm. pulverized limestone

The special potash treatment is indicated in the table of results.

Table 9

Greensand Marl as a Source of Potash—Barley, Oats and Buckwheat

Pot Number	SPECIAL TREATMENT	BARLEY Dry matter grams		OATS Dry matter grams		BUCKWHEAT Dry matter grams	
		Per Pot	Average	Per Pot	Average	Per Pot	Average
1		12.4		18.9		22.0	
2	Check	10.5	11.45	18.9	18.9	25.5	33.75
3		15.0		18.7		22.5	
4	20 gm. marl	14.2	14.60	21.1	19.9	23.5	23.00
5		13.4		16.9		23.6	
6	20 gm. marl + 5 gm. $CaSO_4$	12.0	12.70	20.7	18.8	25.8	24.7
7		19.3		22.5			
8	2 gm. K_2SO_4	17.4	18.35	22.7	22.6		

Barley, oats and buckwheat were grown in the pots, the fertilizer treatment being repeated for each separate crop. After growing about 60 days, the crops were harvested and samples dried and weighed. The results are reported in table 9.

From the averages it will be noted that the yield from the marl-treated pots is only a little greater than the yield from the check pots. Potassium sulfate resulted in a fair increase of barley. (No pots were set up with potassium sulfate for buckwheat, as there was not sufficient soil.)

The yields of oats and buckwheat, especially, are about such as are usually obtained in pot experiments even when soluble potash salts are used, and this would indicate that these crops, like the soybeans, are able to secure from the natural soil materials a large proportion of the potash that they require, and therefore the potash furnished in the form of marl or sulfate did not produce a pronounced effect. This is even more strongly brought out in the result from the residual crop of soybeans which followed the other crops. On harvesting the barley, oats and buckwheat, all pots were seeded to soybeans without further application of fertilizers. The soil in all pots was inoculated by sprinkling with a soil infusion.

Since the pots which were originally seeded to three crops were now all seeded to one crop, there were in reality 6 pots for each treatment, with the exception of the potassium sulfate, for which there were only 4 pots. This should give results more reliable than can be secured when the treatments are run in duplicate only. The beans were harvested as forage on November 2, when the pods were about half filled and before the leaves had fallen badly. The nodules on the roots were abundant, giving evidence of good inoculation. The samples were dried and prepared in the usual way. In addition to recording dry weights, the percentages of nitrogen and of potash were determined. The special fertilizer treatment which was given for the original crops and the analytical data are reported in table 10.

The average yield of dry matter for the six check pots is 19.9 gm., while the average for all the treated pots is 20.23 gm., the difference being an almost negligible one. The average for the four pots that received potassium sulfate is even less than for the check, the amount being 18.15 gm. The absence of soluble potash has evidently had no deleterious effects upon the accumulation of nitrogen. Indeed, the average amount accumulated on the potassium sulfate pots is less than the amount accumulated on both the check pots and the marl-treated pots.

Table 10

Greensand Marl as a Source of Potash—Residual Crop: Soybeans

Pot No.	SPECIAL TREATMENT	Dry matter grams		Per cent nitrogen	Average	Nitrogen grams		Per cent potash (K_2O)	Average
		Per pot	Average			Per pot	Average		
1		19.8		2.357		.467		1.73	
2		19.2		2.441		.469		2.04	
9	Check (no potash)	22.0	19.90	2.478	2.47	.545	.491	1.51	1.68
10		18.5		2.784		.515		1.51	
17		22.9		2.329		.533		1.58	
18		17.0		2.450		.417		1.70	
3		22.0		2.663		.586		1.60	
4		20.0		2.357		.471		2.07	
11	20 gm. marl	23.1	21.17	2.858	2.53	.660	.537	1.52	1.74
12		20.1		2.524		.507		1.74	
19		24.0		2.320		.557		1.47	
20		17.8		2.478		.441		2.05	
5		23.5		2.339		.550		1.82	
6		18.9		2.376		.449		1.99	
11	20 gm. marl	23.4	20.68	2.301	2.40	.538	.491	1.48	1.69
14		17.3		3.035		.525		1.62	
21		22.1		2.060		.455		1.57	
22		18.9		2.283		.431		1.67	
7		15.2		2.626		.399		3.15	
8	2 gm. K_2SO_4	19.0	18.15	2.598	2.56	.494	.464	3.26	3.24
15		20.5		2.441		.500		3.16	
16		17.9		2.580		.462		3.37	

The amount of nitrogen accumulated for the different treatments is as follows:

Average, 6 check pots...................... .491 gm.
Average, 6 marl pots....................... .537 gm.
Average, 6 K_2SO_4 pots.................... .464 gm.
Average, 6 marl plus $CaSO_4$ pots.......... .491 gm.

It cannot be maintained, on the other hand, that the first crop exhausted the supply of potassium sulfate, for the potash determinations made on the crop show the following averages:

Check pots ....1.68 per cent K_2O
Marl-treated pots ....1.72 per cent K_2O
Potassium sulfate pots ....3.24 per cent K_2O

From this it appears that the soybean plant which has at its disposal an excess of soluble potash, stores up an abnormal supply, for certainly if the plant with 1.72 per cent of K_2O can yield as much dry matter and store up as much nitrogen as the plant with 3.24 per cent of K_2O, the latter has about 1.5 per cent more K_2O than it really needs. If it had taken this "luxury" portion from unavailable sources, no fault could be found, but on the contrary, it was taken from an expensive product. A yield of 20 gm. per pot is equivalent to about 2½ tons of dry matter per acre, which is very fair yield. *Thus the results point to the soybean as a plant capable of making a good growth on potash obtained from slowly available sources, and, at the same time, of storing up as much nitrogen as the plant which is supplied with a soluble potash salt.* With a potash content of 1.72, two and one-half tons of dry matter would put back into the soil on an acre 86 pounds of potash, which would become available rather rapidly and thus supply a succeeding crop which could not make such good use of potash from slowly-available sources.

Experiment 3

Experiment 3 was carried out in glazed earthen-ware pots holding 20 pounds of coarse white sand such as was used in Experiment 1. The general treatment given to all pots was as follows:

2	gm. ammonium sulfate
4	gm. acid phosphate
10	gm. pulverized limestone
0.5	gm. magnesium sulfate
0.25	gm. ferric sulfate.

The special treatment given is indicated in table 11. The marl used contained 6.5 per cent of potash (K_2O). The sulfur was used with the thought that its oxidation to sulfuric acid might result in making more of the potash of the marl available. However, the amount of sulfur used proved to be too much, as indicated by the depressed yield of dry matter in these pots.

The soil was inoculated by sprinkling with a soil infusion. The first crop grown was Canada field peas.

With the exception of those pots to which sulfur was added, all treatments resulted in some increase over the check, the greatest increase being with potassium chloride (Muriate) and the second greatest with 20 gm. of marl and 5 gm. of calcium sulfate. The increase with marl alone amounts to 2.35 gm.

After harvesting the Canada field peas, the soil was emptied from the pots, thoroughly mixed and 1 gm. of ammonium sulfate added to each portion, after which the portions were returned to the respective pots and 20 Guelph soybeans seeded to each. These were inoculated with a soil infusion from soybean plots. With two exceptions these made a good growth, the color and abundance of nodules indicating good inoculation. They were harvested as forage at the end of about 80 days, when pods were well filled but still green. The crop on pot 7 was a failure, but this does not appear to have been due to the sulfur, otherwise the crop on pot 8 would not have been so good. The weights of dry matter are reported in table 11 along with the weights of Canada field peas.

From a study of the table it will be observed that, with the exceptions noted, the yields are fairly uniform, the highest average being 26 gm., and the lowest 23.1 gm., while the average for the pots that received 2 gm. of muriate of potash is scarcely one gram more than the average for the check pots.

The results here reported bear out the statements made in connection with the preceding experiments to the effect that soybeans, when inoculated and provided with lime and available phosphate can secure such potash as they require up to the time the pods are about half grown from slowly-available materials, such as greensand marl, or natural soil material.

Table 11

Greensand Marl as a Source of Potash—Canada Field Peas and Soybeans

Pot Number	SPECIAL TREATMENT	FIRST CROP Canada Field Peas		SECOND CROP Soybeans	
		Dry matter grams	Average grams	Dry matter grams	Average grams
1		9.8		24.0	
2	Check	9.0	9.4	23.8	23.9
3		11.0		0.0*	
4	20 gm. marl	12.5	11.75	23.1	23.1
5		14.1		25.7	
6	20 gm. marl + 5 gm. $CaSO_4$	12.5	13.30	24.2	24.95
7		3.8		0.0*	
8	20 gm. marl + 3 gm. sulfur	1.9*	3.80	26.0	26.00
9		3.0*		20.7	
10	2 gm. KCl	16.2	16.20	28.9	24.80

*Omitted from average.

Summary

The availability work with phosphorus and potassium compounds may be summarized as follows:

1. When soybeans were grown in coarse white sand, basic slag as a source of phosphorus gave about as good yields as acid phosphate. Under the same conditions, blue rock phosphate yielded only slightly more than the check. Brown rock gave somewhat better yields than the blue rock.

2. The average percentage of nitrogen in the dry matter (soybean hay) was about the same with basic slag as with acid phosphate. It was distinctly and uniformly less with raw rock and also where no phosphate was used.

3. On a coarse white sand with greensand marl as a source of potash, barley and buckwheat gave greatly increased yields over the check pots.

4. On a coarse yellow sand containing 1.09 per cent of total potash (K_2O), oats and buckwheat gave very fair yields without potash treatment, and applications of marl did not appreciably increase the yields.

5. On the same soil barley showed a slight increase over the check for the marl treatment.

6. On the white and also on the yellow sand, soybeans, when inoculated and supplied with available phosphates and lime, gave practically as good yields on the check pots as on the marl-treated pots up to the time the pods were about one-half filled. When allowed to mature there was an appreciable falling off in the yield of seed on the check pots, but the yield of stalks was about the same on the check pots as on the treated pots.

7. Dry matter (soybean hay) from check pots and from marl-treated pots contained quite as high a percentage of nitrogen as that from pots treated with a soluble potash salt.

8. The per cent of potash (K_2O) in dry matter (soybean hay) from pots treated with soluble potash was notably higher than in that from marl-treated pots or the check pots, but this appears to be a "luxury" consumption since the yield of dry matter and percentage of nitrogen are not thereby increased.

9. The work here reported indicates that there is a very close connection between the presence in the soil of soluble phosphates and the accumulation of nitrogen by the soybean plant.

10. It also shows that the soybean, when inoculated and furnished with lime and soluble phosphates, can make a good growth and accumulate a high percentage of nitrogen, up to the time the pods are half filled (hay), without the aid of readily soluble potash compounds.

11. The work suggests the possibility of utilizing the potash of greensand marl and the potash of natural soil materials by growing soybeans and possibly certain other crops, which could be returned to the soil and thus furnish available potash for those crops which cannot so readily utilize potash from these natural sources.

REPORT OF THE DEPARTMENT OF BOTANY

Department of Botany

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* Resigned October 1st, 1917, to join American Army.

† On, or near, February 17th, 1917, Mr. Piper met a tragic death. He had won high honors at the University of Vermont, where he was graduated the previous June. Mr. Piper was a man of the choicest ideals and gave promise of filling a high place of usefulness.

¶ Several College graduates have worked in the Department for brief periods during the year.

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Report of the Department of Botany

Byron D. Halsted

INTRODUCTION

The work in the botanical department is under the three projects approved some years ago, namely: (1) heredity, (2) environment and (3) toxicology. The first and second projects are carried on with the subjects in both the open field and the greenhouse, while the third is mainly under glass and with the plants having environmental control.

The subjects employed under Heredity are the vegetable fruit plants, to which are added corn, soybeans and some ornamental plants, as nasturtium. With corn the chief line of study during the past year has been that of the influence of the character of the F_1 cob and seed upon the following crop. The results thus far obtained suggest the importance of selecting at the outset of the breeding the type of ear and grain desired.

Work is progressing in the study of reciprocal crosses with beans, corn, eggplants, peppers and tomatoes and further evidence is being obtained to show that, for a full understanding of the practical value of a union between two kinds of plants, the combinations must be made in both directions and between the same pure-type parent plants. The value in breeding of the factors for productiveness is being studied in several crops, with the view of gaining further information concerning the ill effects of barren and non-prolific plants upon the offspring of heavy bearers in general truck growing and commercial seed farming. With beans, for example, this may lead to the removal of podless plants from the field at an early stage of their growth and a more general suckering of corn, including the removal of earless stalks.

Under Environment the studies lie along two distinct lines, namely: (1) that regarding the position of the seed upon the plant and particularly the location of the seeds in the pod in beans, peas and soybeans, and (2) that of factors that are outside of the plant. The results already obtained in the studies of environment within the plant indicate that there is a marked difference in crop-producing value dependent upon the position of the seed. With corn it is shown that the grains centrally located upon the cob are the best for planting, and with beans the end seeds in the pods are less viable and the seedlings less vigorous than those borne midway of the series. The studies of environment without the plant are chiefly with the position of the seed in the soil and the depth of planting. The former studies are with large seeds like lima beans in the greenhouse, and the latter with corn and common beans in the open.

Under Toxicology the work has been as follows: (1) Studies were made of the effects of certain fertilizer salts upon the development of soybeans and buckwheat, with special reference to the study of the nature of the specific injuries produced in the plants by excessive application of the salts, when employed singly and in combination with complete nutrient mixtures in soil cultures, in sand cultures and in water cultures. (2) Researches were conducted for the purpose of studying in detail the effects of various combinations of fertilizer salts upon the growth of the two species of plants above named. Investigations were carried out which aim, in part, to determine whether the fertilizer combinations which produce good growth during the early stages of plant development (seedling stage) will produce equally good growth during that stage when the plants are nearing maturity and are developing seed. A study was made also of the nature of the injurious effects produced in those plants by poorly-balanced combinations of the fertilizer salts employed. These investigations were carried out in the experimental greenhouse under such conditions of control as are possible in work of this nature.

STUDIES ON HEREDTY AND ENVIRONMENT

THE RELATION OF EAR-TYPE IN THE F_1 TO THE CHARACTER OF THE FOLLOWING CROP

The test consisted in the selection for planting of: (1) a good ear that most resembled one parent and (2) an ear that most resembled the other parent. The harvest embraced a measurement of the length of each stalk when in full tassel, and a record of the weight, length and width and of other characters of each ear.

Several F_1 crosses were tested in this manner and a large amount of undigested data are accumulated. In table 1 some results are given for the cross of Golden Queen upon Iowa Silvermine. The parents and the F_1 were also grown in the same block of 230 hills.

Table 1

Results of Cross of Golden Queen on Silvermine

Kind planted	Length of Stem cm.	Ear Weight gm.	Ear Length mm.	Ear Width mm.
Golden Queen	202.4	81.0	146.6	30.8
Iowa Silvermine	249.0	234.4	185.3	48.0
Golden Queen upon Iowa Silvermine F_1	265.2	187.0	181.7	36.2
Iowa Silvermine F_2 like G. Q.	244.8	156.5	168.4	38.7
Iowa Silvermine F_2 like I. S. M.	249.7	162.8	165.1	38.9

Table 1 shows that the Golden Queen plants have a somewhat shorter stature than those of the Iowa Silvermine, and that the F_1 exceeds the larger parent, while the F_2 has practically the same length of stem as the Iowa Silvermine. There is a great difference in weight of the ears of

the parents—a ratio of nearly 1 to 3. The weight of the F_1 ears (187.0 gm.) is far above the mean of the weights of the parents (152.7 gm.) while that of the F_2 (159.7 gm.) exceeds the parental mean by only 4.6 *per cent.*

There is a similar difference in the length of ear, the Silvermine having both a longer and much wider ear than the Golden Queen. In the F_1 the ear approaches those of the Silvermine in both length and in width, the geometric mean of the parent being approximated.

The plants from the ear like the Golden Queen are shorter than those from the ear like the Iowa Silvermine, and their ear-weights are less. In the size of ears there is no marked difference, but in shape, as in weight, the offspring follow the mother ear.

Golden Queen upon Country Gentleman

In this cross both parents have long stalks and comparatively small ears, but one is a yellow pop with grains in many rows, while the other is a high-grade sweet corn with the grains arranged without order (*zigzag*).

The F_1 ear chosen for planting, and resembling the Golden Queen was 130x33 mm. (in length and width), weighed 84 gm. and had its 680 grains arranged zigzag, while its mate in the test, representing the Country Gentleman, was 210x42 mm., weighed 175 gm. and had its 750 kernels in rows which inclined to be spiral.

Table 2

Results of Cross of Golden Queen upon Country Gentleman

Kind planted	Stem Length cm.	Ear Length gm.	Ear Width gm.	Ear Weight gm.
Golden Queen	202.4	145.6	30.8	81.0
Country Gentleman	213.6	215.3	46.9	158.0
Golden Queen upon Country Gentleman F_1	255.0	160.9	37.3	102.3
Golden Queen upon Country Gentleman F_2, like G. Q.	284.2	161.5	34.3	103.8
Golden Queen upon Country Gentleman F_2, like C. G.	264.9	175.5	36.4	127.5

Table 2 shows the averages for a block of plants of each parent and their F_1, and for the F_2 for two groups, namely, the set of plants grown from an ear resembling (1) the Golden Queen and (2) the Country Gentleman parent, respectively.

It is seen that the Golden Queen is smaller in plant stature and dimensions and weight of ear than the Country Gentleman. The F_1 gave a length of stalk much exceeding the taller parent, and ears that were between those of the parents in all the three characters recorded.

In the F_2 the plants from the small grains of the ear resembling the Golden Queen exceeded those of the taller parent, but were not as long as those of the F_1. The ear length and width were less than those of

the Country Gentleman and somewhat in excess of the F_1, but in width they approached the Golden Queen.

The large grains from the ear that was selected for its large size and resembling the Country Gentleman, but not zigzag, yielded a block of plants that averaged larger in all recorded points than the adjoining block of the same cross and generation. The stalks were 11.3 per cent longer and the ears 10.8 per cent longer, 10 per cent wider and 12.3 per cent heavier than those of the block planted with grains from the smaller ear.

No attempt has been made to connect this desirable increase in output with the cause. When the selection is made within a variety or a cross between two well established types, as in this instance, it may be true that, all things being equal, the larger grains have an advantage over the smaller ones, because of the greater bulk of the embryo and the correspondingly larger amount of endosperm to feed the seedling during its initial growth. Again, under the same circumstances the factors for size may be the active agents for determining the differences that have been recorded.

Whatever the reasons may be, the test points toward the rigid selection of the ears that are desired in the crop.

In addition to the above characters, a record was made of the disposition of the grains upon the ears for the F_2 with the following results:

	Straight rows	Partly zigzag	Zigzag	Total
Seed Ear like Golden Queen	36	12	216	264
Seed Ear like Country Gentleman, not zigzag	129	33	98	260
Totals	165	45	314	524

This display shows a great difference in the distribution of the types of grain-arrangement. When all showing zigzag formation are combined, the ratios become:—

	Straight rows	Zigzag
Seed Ear like Golden Queen	13.6 per cent	86.4 per cent
Seed Ear like Country Gentleman	49.6 per cent	50.4 per cent

It is seen that the small ear, representing the Golden Queen in dimension, weight and size of grain, but not with zigzag arrangement, gave offspring very largely of the zigzag type, while the large straight-rowed ear gave nearly an equal number of ears of each of the two types, showing the recessiveness of the factor for zigzag arrangement.

ENVIRONMENT AS INFLUENCING VIABILITY AND VIGOR

Depth of Planting—Corn, Beans, Soybeans

Corn

Six types of corn grains were used in a test of the influence of depth of planting upon viability of the seeds and vigor of the plants: (1) large

flint, (2) large floury, (3) large sweet, (4) small flint, (5) small floury, (6) small sweet.

It is too soon for more than a general statement of some of the results.

The following are the percentages of viability for the six hundred grains planted at each of the several depths:

1 inch deep	94.0
2 inches deep	91.5
3 inches deep	85.0
4 inches deep	81.5
5 inches deep	57.9
8 inches deep	28.7

It is seen that the number of grains that failed increases uniformly to 4 inches, and then it rises rapidly to nearly half at 6 inches, and it is much higher at the maximum depth of 8 inches.

The large grains withstood the adverse condition of great depth much better than did the small kernels, as shown in table 3.

Table 3

Influence of Depth of Planting on Viability of Corn

Character of Seed Planted	Per cent of Viability 1 to 2 inches depth	8 inches depth
Flint, large	99	44
Flint, small	100	19
Floury, large	96	39
Floury, small	90	25
Sweet, large	100	28
Sweet, small	83	17

The several depths did not seem to exert much influence upon the length of the stalks, but it must be remembered that those plants from the deeper plantings had more soil and air space than the others, because of the larger number of failures. The combined averages of height of plant for the six depths is as follows:

1 inch deep	183.2 cm.
2 inches deep	180.0 cm.
3 inches deep	187.8 cm.
4 inches deep	185.6 cm.
6 inches deep	189.3 cm.
8 inches deep	179.1 cm.

The maximum depth gave the shortest plants, but the differences between the six sets do not indicate that depth of planting had any marked influence upon the stature of the plants. A corn seedling, when it reaches the surface of the soil, adjusts itself to the location and is a "surface feeder" regardless of the length of mesocotyl needed to secure the adjustment.

Influence of Depth of Planting Upon Formation of Suckers

Table 4

Suckers Formed on Plants from Seed Sown at Different Depths

NUMBER OF SUCKERS

	1 in.	2 in.	2 in.	4 in.	6 in.	8 in.	Total	
Flint large	24	11	15	48	38	38	174	} 289
Flint small	41	22	17	19	12	4	116	
Floury large	79	84	76	57	46	24	366	} 517
Floury small	34	28	29	11	29	20	161	
Sweet large	27	56	43	33	26	7	192	} 240
Sweet small	15	15	6	2	4	6	48	
	——	——	——	——	——	——	——	
Totals	220	216	186	170	165	99	1,046	
Per Stalk	.390	.393	.368	.347	.447	.569		

Table 4 shows that the suckers are more numerous in the deeply planted rows and next in the shallow planted rows. A separation of the results upon the basis of texture gives the following: flint, 289; floury, 517; sweet, 240; or 27.6 per cent, 49.40 per cent and 23.0 per cent, respectively. The suckering is nearly twice as great from the floury as from either of the other two textures. The sweet grains are lowest in this respect.

When classified upon the basis of size of grain the results for suckering for each depth are as follows:

NUMBER OF SUCKERF

	1 in.	2 in.	3in.	4 in.	6 in.	8 in.	Total
Large grains	130	151	134	138	110	69	732
Small grains	90	65	52	32	45	30	314
							——
							1,046

Suckers are more numerous from the large grains at each depth, the total percentage being 70.1, while it is only 29.9 for the parallel set from small grains. Therefore, from the two view-points, the kind producing the greatest percentage of suckers is the Hopi, a variety with large

floury grains, and the sort with the least number of suckers is the Country Gentleman, a kind with small, sweet grains. The association here shown needs further consideration to determine just where the factor for suckering lies, if not in grain texture and size.

Beans

Five typical varieties of beans were planted to the depth of one, two three, and four inches, respectively. There were twenty hills for each depth of each variety. At this early date it is possible to give only the viability of the seeds and the number of pods produced.

Table 5

Combined Totals of the Five Varieties

Depth of Planting	Number of Plants Harvested	Viability of Seeds	Pods per Plant	Total Pods
1 inch	295	50.70	19.80	5,841.0
2 inches	289	49.15	21.28	6,149.9
3 inches	212	36.05	20.08	4,252.7
4 inches	175	29.76	17.22	3,013.5
Totals and Averages	961	41.28	19.59	19,257.1

Table 5 shows that the number of plants harvested was greatest from the rows where the planting was 1 inch deep, but it was nearly the same from the rows with seeds planted 2 inches deep. There was a large decrease from the 3-inch depth and still more from the maximum depth. The same difference is shown in the percentages of viability of the seeds, which ranged from 50.17 for the 1-inch depth to 29.76 for the 4-inch planting. These percentages are all very low and this is partly attributed to poor seeds of some kinds and somewhat to the unfavorable weather while the seedlings were making their first growth.

The number of pods to a plant does not vary greatly among the four depths of planting. Owing to the many failures in all the depths there was no crowding of plants, but it is possible that the greater soil and air-space for the few plants in the rows where the seeds were planted 4 inches deep was in their favor.

The total crop of pods for each type of planting gives the most practical result of the test, provided that the pods are of equal value for all depths. This shows that the largest crop is from the rows with seeds planted 2 inches deep, followed closely by those with seeds 1 inch deep. The rows with seeds 4 inches deep show a light yield.

The test permits of a record of the fact that beans planted to the depth of 4 inches may produce a light stand and the surviving plants

yield nearly as well as those that are from shallow-planted seeds. It is possible that the plants that bore a crop were the more vigorous ones, and at less depth they might have yielded more heavily than is shown in the record.

Table 6

A Comparison of the Varieties of Beans

Variety	Plants harvested	Viability	Pods per Plant
Early Wonder	75	17.13	23.0
Pea Bean	100	20.84	21.9
White Marrow	151	31.46	20.2
Early Refuge	270	56.24	6.0
Henderson Lima	375	78.13	26.6
Total	1,073		

Table 6 shows that the first three kinds of beans in the list were very low in viability and only the representative of the Lima group made a good stand. There was but a small range in the pod-production excepting that of the Early Refuge which was far below the others.

The results with the Henderson indicate that it may be planted to a greater depth with safety than the field beans. This is shown in the following comparative table, giving the number of plants produced for each depth for the 120 seeds used.

	1 inch	2 inches	3 inches	4 inches
Pea Bean	52	30	13	5
Henderson	88	103	101	83

The results also show that the Henderson at three inches had the largest yield of pods per plant. In total yields of pods the following records were made:

	1 inch	2 inches	3 inches	4 inches
Pea Beans	1180	753	305	82
Henderson	2411	2750	2878	1967

The pea bean declines in yield from the 1-inch to the maximum depth, while the Henderson increases somewhat from 1 to 3 inches and declines for the 4-inch depth. From these results it may be expected that lima beans should be planted near to 3 inches deep, and for the large-seeded kinds even a greater depth may be advisable, but so much depends upon soil and season that no hard and fast rule for each depth can be given.

Soybeans

Two hundred seeds of Ito San soybeans were planted at each of the following depths: 1, 2, 3 and 4 inches. Only partial results are now ready for this report.

Table 7

Influence of Depth of Planting on the Viability of Soybeans.

Depth of Planting	Plants Grown	Average Weight of Plant
		gm.
1 inch	125	98.5
2 inches	130	96.4
3 inches	132	101.7
4 inches	112	98.0

Table 7 shows that the viability was nearly the same for all depths excepting the maximum depth, where the percentage was only 56.0. The weight of the plants for the 3-inch planting was slightly greater than elsewhere. It remains to be shown at what depth are produced the most and heaviest seeds.

Position of Seeds in the Pod

All seeds in a legume are not alike in size and shape, and therefore in any unassorted lot of beans, peas, etc., there will be a considerable range in form and dimension, and therefore in weight as well. It is the intent of this study, a fragment of which is reported upon here, to determine whether a somewhat constant relationship exists between the position of the seed in the pod, and its weight, size and value for crop-production.

The preliminary test consisted in the growth of a quantity of Ito San soybeans in 1915 from which seeds were secured for the experiment that followed the next year. Seeds in equal numbers (50) were planted of those borne singly, two, and three in full pods; that is, there were 6 sets namely: (1) 1-seeded, (2) 2-seeded base, (3) 2-seeded tip, (4) 3-seeded base, (5) 3-seeded middle, (6) 3-seeded tip. As the viability was very high, there were 50 plants of each set, five to a hill, grown in a block of 6 rows, with all the conditions of soil and culture as nearly alike as possible.

The harvest consisted first of a classification of the pods in each set into those (1) without and (2) with abortive ovules, and these groups were again separated according to number of ovules and seeds produced, as shown in table 8.

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[1]The details of this test were carried out by Miss Mathilde Groth, laboratory assistant, to whom many thanks are due for patience and skill.

Table 8

Classification of the Pods of the Crop

Type planted.	Total	Without Aborts 1-ov* 1-sd.**	2-ov. 2-sd.	3-ov. 3-sd.	4-ov. 4-sd.	With Aborts 2-ov. 1-sd.	3-ov. 1-sd.	3-ov. 2-sd.	4-ov. 2-sd.	4-ov. 3-sd.
1-seeded	3352	470	1082	815	25	310	159	463	5	23
2-seeded base	*4333*	*375*	*1864*	*962*	*44*	*566*	*101*	*404*	*0*	*17*
2-seeded tip	3984	381	1512	1095	23	367	130	458	0	18
3-seeded base	3101	455	890	606	48	438	41	593	0	31
3-seeded middle	4210	495	1125	1115	37	346	219	833	8	32
3-seeded tip	4862	585	1680	1375	31	453	148	566	0	24
Total	23842	2761	8153	5967	208	2480	798	3317	13	145

*ovuled.
**1-seeded.

In table 8 it is seen that there was a marked difference in the total yield. The largest crop of pods came from the seeds borne at the tip of 3-seeded pods, and the lowest yield from seeds at the base of the same pods. The 2-seeded pods averaged the highest yield and the 1-seeded the lowest.

This test suggests that if possible it might be well before planting to eliminate the basal seeds from the 3-seeded pods and all 1-seeded pods.

Table 9

Classification of the Pods of the Crop in Percentages.

Type planted	Without Aborts 1-ov. 1-sd.	2-ov. 2-sd.	3-ov. 3-sd.	4-ov. 4-sd.	With Aborts 2-ov. 1-sd.	3-ov. 1-sd.	3-ov. 1-sd.	4-ov. 2-sd.	4-ov. 3-sd.	Totals Without Aborts	With Aborts
1-seeded	14.02	32.20	24.30	0.70	9.24	4.75	13.80	0.10	0.68	71.22	25.57
2-seeded base	8.68	43.00	22.20	1.01	13.20	2.33	9.35	0.00	0.30	74.88	25.18
2-seeded tip	9.56	38.00	27.50	0.58	9.21	3.26	11.50	0.00	0.45	75.64	24.42
3-seeded base	14.60	28.60	19.50	1.54	14.20	1.32	19.10	0.00	1.00	64.24	35.62
3-seeded middle	11.70	26.80	26.60	0.88	8.25	5.21	19.80	0.19	0.75	65.98	34.20
3-seeded tip	12.00	34.60	28.20	0.63	9.30	3.20	11.60	0.00	0.49	75.48	24.59
Total	70.56	203.20	148.30	5.34	63.40	20.07	85.15	0.29	3.67		
Averages	11.76	33.86	24.72	0.89	10.57	3.35	14.19	.05	0.61	71.23	28.77

A high percentage of 1-ovuled 1-seeded pods is associated with the crops from 1-seeded pods and the basal ends of 3-seeded pods.

The highest percentage of 2-ovuled 2-seeded pods is associated with the crops from 2-seeded pods with both the basal and tip seeds.

The highest percentage of 3-ovuled 3-seeded pods is associated with crops from tip seeds of 3-seeded pods.

It is noted that there is a wide range in abortiveness, it being comparatively low in the crop from tip seeds of both 2 and 3-seeded pods, and high in crops from base and middle seeds of 3-seeded pods. The

crops from 2-seeded pods, both base and tip seeds and 1-seeded pods are low in abortiveness. Therefore, as to position in the pod the tip seeds yield the larger percentage of full pods. The tip seeds average 75.04 per cent of pods without aborts, while the basal seeds yield 69.56 per cent of whole pods.

From this point of view it is evident that the basal seeds of 3-seeded pods yield a large percentage of pods with abortive ovules, and in that respect also are not as good for crop production as the tip seeds.

Table 10

Weight of Seeds as Related to Position in the Pod of the Seed Planted

Type Planted	Total Seeds	Total Weight
1-seeded	6677	1301.0
2-seeded base............	8679	1601.0
2-seeded tip.............	8240	1532.5
3-seeded base............	6000	1138.5
3-seeded middle..........	9899	1876.5
3-seeded tip.............	9899	1876.5
Total	48076	9028.0
Average	8013	1504.7

Table 10 shows that the yield of seeds was best in the 3-seeded tip crop, while that from the basal seeds of the same pods was the poorest and the middle seeds gave an intermediate crop.

For pods as a whole the best average yield (1566.8 gm.) was from the 2-seeded pods, and next (1531.2 gm.) from the 3-seeded pods, and therefore poorest (1301.0 gm.) from the 1-seeded pods.

Table 11

Weight of Seed as Related to its Position in the Pod

Type Planted	Without Aborts				With Aborts			Average Without Aborts	Average With Aborts
	1&1	2&2	3&3	4&4	2&1	3&1	3&2		
	gm.	gm.	gm.	gm.	gm.	gm.	gm.	gm.	gm.
1-seeded	.209	.199	.193	.209	.201	.195	.188	.200	.195
2-seeded base	.191	.187	.179	.190	.187	.183	.188	.187	.186
2-seeded tip	.192	.187	.184	.163	.192	.196	.187	.182	.192
3-seeded base	.201	.192	.184	.185	.193	.207	.189	.191	.196
3-seeded middle	.194	.195	.182	.172	.189	.178	.182	.183	.183
3-seeded tip	.202	.193	.185	.186	.186	.170	.178	.192	.178
Totals	1.189	1.143	1.107	1.095	1.148	1.129	1.112		
Averages	.1982	.1905	.1845	.1825	.1912	.1882	.1853		

From the averages in table 11 it is seen that among the full pods the heaviest seed is for the 1-seeded pods, and the weight diminishes as the pods increase in number of seeds, the lowest being from the 4-seeded pods. Starting at a lower weight there is a similar decrease among the

pods having abortive ovules, that is, single seeds from 2-ovuled pods are heavier than those from 3-ovuled pods, and the lightest are from 3-ovuled pods with two seeds. There were very few 4-ovuled pods with abortive ovules (as shown in table 8) and they are not considered here.

Table 12

Comparison of Weights in the Same Pod—Full Pods

	Two-Seeded Pods	Weight (gm.)		*Three-Seeded Pods*	Weight (gm.)		
Type Planted	No. Pods	Base	Tip	No. Pods	Base	Middle	Tip
1-seeded	1082	203.5	215.0	815	148.0	162.0	162.0
2-seeded base	1864	330.5	358.5	962	161.5	181.0	176.5
2-seeded tip	1512	275.0	290.0	1095	187.0	210.0	208.0
3-seeded base	890	169.0	173.5	605	104.0	115.0	115.0
3-seeded middle	1125	203.0	215.0	1115	188.5	210.0	212.0
3-seeded tip	1680	310.0	331.0	1375	234.0	265.0	265.5
Totals	8153	1506.0	1579.5	5964	1023.0	1143.0	1139.0
Average Seed		.1847	.1937		.1714	.1915	.1909
Average per Pod		.1892				.1846	

From table 12 it is noted that the seeds in 2-seeded pods were heavier than those borne in 3-seeded pods, and those in the tip are heavier than those at the base, the basal ones being 94.8 per cent of the weight of those at the free end of the pod.

The heaviest seeds in the 3-seeded pods are produced in the middle, although the difference between these and those at the tip is but slight. The basal seeds, however, are much lighter, namely, only 89.4 per cent of the weight of the middle seeds.

The basal seeds in both types of pods are inferior in weight to those borne elsewhere.

Table 13

Abortiveness—Two-Ovuled Pods

Type Planted	No. Pods	Base Seed Present	Weight	Tip Seed Present	Weight
			gm.		gm.
1-seeded	310	60	12.2	250	50.0
2-seeded base	566	90	17.5	476	88.5
2-seeded tip	367	53	10.5	314	60.0
3-seeded base	438	64	12.5	374	72.0
3-seeded middle	346	52	9.5	294	56.0
3-seeded tip	453	83	15.0	370	69.5
Totals	**2480**	**402**	**77.2**	**2078**	**396.0**
Average			**.192**		**.191**

Table 13 shows that the abortiveness in the basal ovules is 83.79 per cent and only 16.21 per cent among those of the terminal portion. It is also shown that the average seed weights are nearly the same for both positions: 0.192 gm. for base and 0.191 gm. for tip. These figures, when compared with full 2-seeded pods (table 12) show that the basal seed when alone in a 2-seeded pod, is heavier than the one grown with its mate.

Table 14

Abortiveness—Three-Ovuled Pods

Type Planted	3-ovuled 1-seeded		3-ovuled 2-seeded	
	No. Seeds	Weight	No. Seeds	Weight
		gm.		gm.
1-seeded	159	31.0	926	175.6
2-seeded base	101	18.5	808	148.0
2-seeded tip	130	25.5	916	171.5
3-seeded base	41	8.5	1186	227.0
3-seeded middle	219	39.0	1666	303.0
3-seeded tip	148	25.0	1132	201.5
Totals	798	147.5	6634	1226.6
Average		0.185		0.185

From table 14 it is noted that there are many more pods with 1 seed missing than with 2 ovules abortive. It is further shown that the seed weight is the same (0.185 gm.) for both sets of pods and that this is lower than with single seeds in 2-ovuled pods.

Table 15

Abortiveness—Three-Ovuled Two-Seeded Pods

Type Planted	No. Seeds	Weight gm.	No. Seeds	Weight gm.	No. Seeds	Weight gm.
1-seeded	163	31.5	336	63.1	427	81.0
2-seeded base	106	19.0	298	54.0	404	74.5
2-seeded tip	90	20.0	419	72.5	413	79.0
3-seeded base	153	30.0	483	88.5	550	105.5
3-seeded middle	324	59.0	533	97.5	809	146.5
3-seeded tip	81	14.0	508	88.0	543	99.5
Totals	917	173.5	2576	463.6	3246	586.0
Average weight		0.189		0.180		0.186

The abortiveness in the basal position was 72.6 per cent (table 15) in the middle 22.4 per cent and the tip 5.18 per cent; that is, it decreased very rapidly from the base to the tip.

There were a total of 798 3-ovuled pods, having only a single seed each. In these the average seed weights were: base 0.166 gm., middle, 0.185 gm.; tip, 0.186 gm. The abortiveness for the basal position was 95.0 per cent, that for the middle place 76.0 per cent and for the tip 29.6 per cent. In other words, the abortiveness decreased rapidly from the base to the tip, as has been shown elsewhere for other pods.

Observations

From this single trial there appears to be a marked difference in the yield due to the position of the seeds in the mother pod. The seeds borne at the tip of 3-seeded pods produce a much better crop than those at the base of the same pods.

The crop from tip-seeds shows less abortiveness in their pods and the highest percentage was in the crop from basal ends of 3-seeded pods.

It is shown that in both pods without and with aborts the weight of the individual seed diminishes as the number of seeds in the pod increases.

In 2-seeded full pods the heaviest seeds are borne at the tip, in the 3-seeded full pods those at the middle are slightly heavier, the basal being quite inferior.

Abortiveness is chiefly in the basal ovules, and least in the tip position.

Abortiveness is in positive correlation with weight of seed. For example, basal seeds of 3-seeded pods, associated with 72.0 per cent of abortiveness, have low weight and weak productive power.

A STUDY OF LIMA BEAN PODS

Two widely different varieties of lima beans were chosen, namely, the Henderson, representing the type with small thin-walled pods bearing small seeds, and the Burpee, having comparatively large thick-walled pods and large seeds. There are many other differences in stem, leaf and flower that further indicate that the two varieties are members of distant groups of lima beans.

The pods were taken from plants that had been pulled September 28, 1916 and from which no pods had been previously removed. All pods that contained any seeds were used, that is, the results are derived from the whole crop.

A classification was first made into (1) those pods that had all the ovules developed and (2) those with abortive ovules as shown below:

Variety	Pods without Aborts	Pods with Aborts	Total Pods	Per Cent of Aborts
Henderson	1096	711	1807	39.4
Burpee	186	288	474	60.8
Totals	1282	999	2281	

It is noted that the Henderson *far outnumber the* Burpee, and *that* the abortiveness of the two kinds is as 2 to 3 in favor of the Henderson.

The pods when grouped as to the number of their ovules give the following results in percentages:

	2-ovuled	3-ovuled	4-ovuled
Henderson	9.0	83.8	7.2
Burpee	24.5	54.6	20.9

It is here shown that the 3-ovuled pods are the most common in both varieties, but the distribution is much more nearly even in the Burpee than in the Henderson.

Table 16

Percentages of Abortiveness within the Type for the General Position in the Pod

Type of Pod	Variety	Base Per Cent	Middle Per Cent		Tip Per Cent	Averages Per Cent
2-ovuled	Henderson	22.0			3.7	12.8
2-ovuled	Burpee	44.8			8.6	26.7
3-ovuled	Henderson	36.6	3.8		2.6	14.3
3-ovuled	Burpee	41.5	11.6		13.9	22.3
4-ovuled	Henderson	33.8	6.2	0.78	3.1	11.0
4-ovuled	Burpee	32.0	24.0	20.0	17.0	23.2

Table 16 shows that the Henderson has little more than half as large a percentage of aborts as the Burpee. The two varieties agree in having much the largest percentage of abortiveness in the basal position, and quite generally it decreases from the base to the tip.

Table 17

Average Weight of Seeds for the Several Positions in the Pod

Type of Pod	Variety	Base gm.	Middle gm.		Tip gm.	All gm.
2-uvuled	Henderson	0.39			0.43	0.41
2-ovuled	Burpee	1.25			1.27	1.26
3-ovuled	Henderson	0.38	0.41		0.42	0.41
3-ovuled	Burpee	1.13	1.20		1.16	1.17
4-ovuled	Henderson	0.35	0.39	0.40	0.39	0.38
4-ovuled	Burpee	1.27	1.30	1.32	1.28	1.29

Table 17 shows that the Henderson seeds are practically one-third as heavy as those of the Burpee. The seeds in the basal position are the lightest in all types of pods in both varieties, while those of the middle positions of 3- and 4-ovuled pods are somewhat heavier than those at the tip.

When the weights are compared with abortiveness in the several positions, a marked inverse correlation is found, that is, the position giving the smallest seeds, within a given type of pod, yields the largest number of aborts.

When the results for each position for both varieties are combined and ranking figures are used in place of weights, the following showing is obtained:

Type of Pod	Base	Middle		Tip
2-ovuled	6th			2nd
3-ovuled	8th	5th		5th
4-ovuled	7th	3rd	1st	4th

In other words, the heaviest seeds of all are in the 4-ovuled pods and at the third position from the base. In like manner it is seen that the second heaviest seeds are at the tip of 2-ovuled pods, followed by the seeds in the second and fourth place in 4-ovuled pods. The basal position inclues all three groups with the lowest weights of seeds.

When the abortiveness is averaged for the two varieties and the ranking figures employed, the following display is obtained:

Type of Pod	Base	Middle		Tip
2-ovuled	2nd			9th
3-ovuled	1st	8th		7th
4-ovuled	3rd	4th	5th	6th

While the inverse correlation between size and abortiveness is not absolute, it is sufficiently strong to warrant consideration in selecting seed for planting. But the factor of position in the pod is an ulterior one that determines the relative size, and therefore is of prime importance in seed selection.

There is likely a causal relation between position in the pod and vigor of seed. In other words, the basal position that is associated with a large percentage of aborts may yield inferior seeds.

It remains to be shown by practical cropping tests just where in the pod the best seeds for planting are located.

RELATION OF PERIOD OF GROWTH OF PLANT TO FRUIT AND SEEDS—NEW WONDER BEAN

One hundred plants were employed in this study. The harvest was made with the endeavor to have each picking represented by a third of the whole crop. This is a desired end that is obviously difficult to reach.

Table 18

Total Harvest and Abortiveness

	Total Pods	Without Aborts	With Aborts	Per Cent with Aborts
First picking	331	120	211	63.7
Second picking	250	80	170	68.0
Third picking	884	238	646	73.2
Total	1465	438	1027	66.9

Table 18 shows that more than half of the pods are in the last picking, and this unequality should be regarded in the deductions. It is further shown that the percentage of pods having one or more ovules abortive is very large, and that it increases from the first to the last picking.

Table 19

Relation of Picking Time to Type of Pod

	Number of Pods	Per Cent	Type of Pod 3-ov.	4-ov.	5-ov.	6-ov.	7-ov.	Average
First picking	395	35.0	66	98	117	90	24	4.77
Second picking	325	28.7	17	70	141	83	14	5.02
Third picking	408	36.3	81	147	103	77	0	4.43
Totals	1128*	100.0	164	315	361	250	38	4.72
Per Cent			14.5	28.0	32.0	22.2	3.3	

Table 19 shows that the number of pods in the mid-season picking is somewhat less than in the other two pickings.

It is further shown that the second picking had the highest average for the number of ovules in the pod, and the last picking the lowest average.

In the mid-season picking the number of 5-ovuled pods nearly equalled that of all the other types combined. The last picking shows a fairly uniform distribution of the pods among the four lower types, with no representatives of the 7-ovuled type.

Table 20 shows that the number of seeds associated with abortive ovules is greater than that produced in full-seeded pods, but this excess is least in the midseason harvest. The heaviest seeds are found in the last picking and the lightest in the second harvest. It is further shown

*Many of the pods, particularly in the last picking recorded in this table, were rejected from further study.

that the weights of the seeds from pods with abortive ovules are uniformly greater than are the seeds from pods without aborts.

Table 20

Relation of Picking Time to Weight of Seeds

	Pods without Aborts		Pods with Aborts		Both combined	
	Number of Seeds	Average Weight	Number of Seeds	Average Weight	Number of Seeds	Average Weight
First picking	620	.240	826	.243	1446	.242
Second picking	607	.229	677	.243	1284	.236
Third picking	680	.224	828	.255	1508	.244
	1907	.230	2331	.249	4238	.242

The following tables (21, 22) set forth the average weight of the seeds as related to their position in the pod. Only pods without aborts are considered, and therefore the numbers of 3- and 7-ovuled pods are so small that they are disregarded.

Table 21

Average Weight of Seeds in 4-ovuled Pods as Related to Position in Pod

	Number of Pods	Base gm.	2nd gm.	3rd gm.	Tip gm.	All gm.
First picking	34	.221	.221	.250	.264	.236
Second picking	15	.220	.233	.286	.286	.256
Third picking	50	.210	.220	.240	.230	.226
All	99	.215	.222	.246	.251	.236

Table 21 shows that the average weights of the seeds are greatest in the mid-season harvest and least in the last picking. It also shows that the weights gradually increase from the base to the tip of the pod.

Table 22

Average Weight of Seeds in 5-ovuled Pods as Related in Position in Pod

	Number of Pods	Base gm.	2nd gm.	3rd gm.	4th gm.	Tip gm.	All gm.
First picking	45	.223	.245	.245	.245	.245	.241
Second picking	42	.214	.222	.246	.258	.222	.232
Third picking	45	.200	.222	.232	.243	.222	.224
All	132	.212	.229	.241	.248	.229	.232

Table 22 shows that the average weights of seeds in 5-ovuled pods decrease from the first to the last picking. There is also shown an increase in the weights of seeds from the base to next below the tip, the tip seeds in weight being equal to those of the position next to the base. The heaviest seeds are next below the tip seeds.

Table 23

Average Weight in 6-ovuled Pods as Related to Position in Pod

	Number of Pods	Base gm.	2nd gm.	3rd gm.	4th gm.	5th gm.	Tip gm.	All gm.
First picking	26	.242	.230	.242	.242	.242	.242	.240
Second picking	48	.215	.215	.229	.229	.229	.215	.222
Third picking	36	.208	.208	.222	.222	.222	.222	.217
All	110	.219	.221	.230	.230	.227	.224	.226

Table 23 shows that the average weights of the seeds in 6-ovuled pods decrease from the first to the last picking, and also that the heaviest seeds are in the middle of the pod.

Table 24

Average Weight of Seeds for the Three Pickings as Related to the Leading Type of Pods

	4-ovuled gm.	5-ovuled gm.	6-ovuled gm.	All gm.
First picking	.236	.241	.240	.240
Second picking	.256	.232	.222	.237
Third picking	.235	.224	.217	.222
All	.239	.232	.226	.233

Table 24 shows that the average weights of the seeds decrease from the first to the last picking.

It is also shown that the weights decrease from the 4-ovuled to the 6-ovuled pods, and the pods with 5 ovules (which is the average number of ovules for this variety of bean) have seeds of practically the average weight for the three types considered in table 24.

The heaviest of all seeds were found in the 4-ovuled pods of the second picking, and in the third and tip positions. The lightest seeds for all three pickings and types of pods were produced in the basal positions of all pods of the last picking. Average seeds were found in the 2nd position from the base in 4-ovuled pods, 3rd from base in 5-ovuled pods, and 4th from base in 6-ovuled pods.

Table 25

Abortiveness in 3-ovuled Pods as Related to Picking Time and Position in the Pod

	Number of Pods	Base per cent	2nd per cent	Tip per cent	All per cent
First picking	44	57.0	21.6	16.7	34.8
Second picking	17	76.6	35.3	23.6	45.1
Third picking	81	56.8	32.1	9.9	36.2
All	142	63.5	33.0	16.7	38.7

Table 25 shows that for 3-ovuled pods the per cent of abortiveness is greatest in the mid-season harvest, and that it decreased rapidly from the base to the tip position of the pod.

Table 26

Abortiveness in 4-ovuled Pods as Related to Picking Time and Position in the Pod

	Number of Pods	Base per cent	2nd per cent	3rd per cent	Tip per cent	All per cent
First picking	98	43.0	16.3	19.4	12.2	22.7
Second picking	70	52.9	32.9	24.3	20.0	32.5
Third picking	147	45.0	11.5	12.2	13.6	20.6
All	315	46.0	17.8	17.1	14.6	23.9

According to table 26 the abortiveness in 4-ovuled pods is greatest in the mid-season picking and there is a general decrease in ovule failures from the base to the tip of the pods.

Table 27

Abortiveness in 5-ovuled Pods as Related to Picking Time and Position in the Pod

	Number of Pods	Base per cent	2nd per cent	3rd per cent	4th per cent	Tip per cent	All per cent
First picking	117	31.6	20.5	19.6	11.1	6.8	18.0
Second picking	141	46.0	20.6	19.8	16.3	12.1	23.0
Third picking	103	20.4	8.6	7.8	7.8	1.9	9.3
All	361	34.1	17.2	16.3	16.8	7.49	17.5

Table 27 shows that for the 5-ovuled pods the abortiveness is greatest in the second picking, and that there is a general decrease in amount from the base to the tip of the pod.

Table 28

Abortiveness in 6-ovuled Pods as Related to Picking Time and Position in the Pod

	Number of Pods	Base per cent	2nd per cent	3rd per cent	4th per cent	5th per cent	Tip per cent	All per cent
First picking	90	28.9	28.9	28.9	32.2	25.6	20.0	27.4
Second picking	83	14.5	13.2	6.0	8.5	4.8	3.6	8.4
Third picking	77	10.4	23.4	9.1	5.2	5.2	2.6	9.3
All	250	18.4	22.0	15.2	16.0	12.4	9.2	15.5

According to table 28 the abortiveness in 6-ovuled pods is greatest in the first picking, and there is a general decrease from the base to the tip of the pod.

Table 29

General Averages for Abortiveness as Related to Picking Time and Ovules in Pod

	3-ov.	4-ov.	5-ov.	6-ov.	7-ov.	All
First picking	34.8	22.7	18.0	27.4	15.5	23.7
Second picking	45.1	32.5	23.0	8.4	30.6	28.0
Third picking	36.2	20.6	9.3	9.3	....	18.9
All	38.7	25.2	16.8	14.9	14.0	....

Table 29 shows, for a general survey, that the abortiveness is highest in the mid-season pods and lowest in those of the last picking. It further shows that within the type of pod the largest percentage is in the 3-ovuled pods and decreases through the other types to the 7-ovuled pods. In the 5-ovuled pods, of which there are the greatest number, the abortiveness is nearest the average in amount.

A STUDY OF THE WEIGHT OF TOMATO FRUIT AS RELATED TO POSITION IN CLUSTER

Full clusters, with all the fruit mature, were taken, and those for each position, counting from the base upward to the tip, were weighed

Table 30

The Weights of Tomatoes as to Position in the Cluster

Kind		Base	2	3	4	5	6	7	8	9	10
Currant-Ponderosa,	Number	207	119	210	221	219	211	174	89	...	...
	Average Weight (gm.)	7.6	7.4	7.2	6.9	6.6	5.7	5.4	4.8	...	...
Yellow Cherry,	Number	82	81	82	74	81	69	45	18	...	...
	Average Weight (gm.)	4.6	4.3	4.3	4.0	3.8	2.2	3.4	3.5	...	...
Magnus-Yellow Cherry,	Number	33	29	30	34	31	20	...	...	...	...
	Average Weight (gm.)	20.3	19.9	19.4	18.1	16.5	14.5	...	...	...	...
Yellow Cherry-Magnus,	Number	63	72	72	65	66	46	10	...	...	...
	Average Weight (gm.)	18.8	18.8	18.7	17.2	15.6	13.9	13.2	...	...	...
Non-Crack,	Number	64	66	65	70	72	72	76	76	68	61
	Average Weight (gm.)	6.1	6.2	6.4	6.7	6.3	6.2	6.1	5.9	5.6	5.3
148-187 Yellow,	Number	82	83	82	66	34	...	...	...	...	...
	Average Weight (gm.)	4.6	4.2	3.7	3.5	3.2	...	...	...	...	...
Cherry Tomato,	Number	154	162	164	172	172	150	81	25	...	...
	Average Weight (gm.)	4.3	4.2	4.0	3.9	3.5	3.1	2.8	2.7	...	...
230-178,	Number	74	71	73	79	78	63	49	27	...	...
	Average Weight (gm.)	17.6	17.0	16.4	15.3	14.0	13.6	12.9	12.4	...	...
Currant Tomato,	Number	66	75	77	82	81	86	82	81	80	76
	Average Weight (gm.)	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.0	1.0

by themselves. As the clusters of different kinds or crosses differ in the number of fruits, an average of all the weighings for any position is not made. From table 30 it is seen that there were some fruits absent in several of the clusters, and it is noted that the highest number pre

sent is usually some points above the base. This absence of a few may be due to a failure to form, or to accident, or to the falling away, due to maturity; this last might obtain with the basal fruits as the fruits mature in a fairly regular order, from the base to the tip of the cluster. For example, in the Currant variety, which has the largest number of fruits in the cluster, the number weighed was 68 for the base, and 76 for the tenth place, or tip, while the sixth place had the highest number (86). In case of a cross, with only 5 fruits in a cluster, the largest number was next to the base, and the smallest in the fifth place, because of the failure of the fruits to form.

Table 31

Relative Weights Shown by Means of Ranking Numerals

Kind	Base	2	3	4	5	6	7	8	9	10
Currant	1	1	1	1	2	2	2	3	4	4
Currant-Ponderosa	1	2	3	4	5	6	7	8		
Yellow Cherry	1	2	2	3	4	7	6	5		
Magnus-Yellow Cherry	1	2	3	4	5	6				
Yellow Cherry-Magnus	1	1	2	3	4	5	6			
Non-Crack	5	4	2	1	3	4	5	6	7	8
148-187	1	2	3	4	5					
Cherry	1	2	3	4	5	6	7	8		
230-178	1	2	3	4	5	6	7	8		

With a single striking exception the basal fruits are heaviest (table 31) and in like manner there is a single exception to the rule of the terminal fruit being the lightest. In the former case this cross is a small-fruited kind, remarkable for its thick skin and has a cluster with the largest fruits near the middle (No. 4). The Yellow Cherry has the smallest fruits third from the tip.

However, as a general rule, there is a gradual falling off in weight from basal fruit to the one at the tip of the cluster in the kinds studied. Among the larger-fruited kinds, where the cluster is a panicle and not a raceme, the results most likely would be different.

SECTION OF PLANT AS RELATED TO CHARACTER OF FRUIT—PEAS

The peas used in the following records were grown in the spring of the current year, and owing to the very unfavorable rainy weather the crop was light and the pods unusually small. Only 140 plants were suitable for study, and from these 484 pods were counted and only 246 were used in the records.

All plants were divided by length into three equal portions and the pods from each considered separately. The basal third produced 69 pods, the middle portion 204 and the tip third 211 pods.

Table 32

Number of Pods Suitable for Records for Each Section of Plant

Portion of Plant	Without Aborts	With Aborts	Per Cent Abortive
Base Third	8	32	80.0
Middle Third	50	54	52.0
Tip Third	29	73	71.5
	87	159	64.6

It is noted (table 32) that the basal portion yielded the largest percentage of pods with abortive ovules, and the largest percentage of full pods were in the middle section.

Table 33

Number of Ovules to the Pod for Each Section of Plant

	4-ov.	5-ov.	6-ov.	7-ov.	Total	Average	Per Cent
Base	0	4	33	3	40	5.98	16.4
Middle	4	62	19	19	104	5.51	42.2
Tip	21	35	36	10	102	5.34	41.4
Total	*25*	*101*	*88*	*32*	*246*		
Per cent	10.1	41.2	35.7	13.1			

The basal pods average the largest number of ovules, and the number decreased toward the tip (table 33).

Table 34

The Number and Average Weight of Seeds for Each Section of Plant

			Weight		
			Without Aborts	With Aborts	Both
	Number	Per Cent	gm.	gm.	gm.
Base	189	16.7	.200	.179	.185
Middle	506	45.0	.200	.173	.187
Tip	263	23.3	.168	.158	.162

Table 34 shows that the greatest number (nearly a half) and the heaviest seeds are from the middle portion; those from the tip section being the lightest. The weight of the seeds averaged larger in pods where there were no abortive ovules.

Table 35

Per Cent of Abortiveness for Each Section of Plant in Relation to Type of Pod

	4-ov.	5-ov.	6-ov.	7-ov.	All
Base	0.0	37.0	20.2	0.0	21.3
Middle	50.0	13.2	3.5	10.5	11.7
Tip	32.1	22.8	15.3	22.8	21.3
All	35.0	18.0	15.9	13.4	17.3

Table 35 shows that the percentage of abortiveness for the pods of the lower third of the plant is the same as for the upper section (21.3 per cent) and nearly twice that for the middle portion. It is further shown that the percentage of abortiveness is largest in the 4-ovuled pods and drops to nearly half as much in the 5-ovuled pods, and decreases somewhat through the 6 to the 7-ovuled pods.

Table 36

Per Cent of Abortiveness for Each Section of Plant as Related to Position in Pod

Section of Plant	Base	2nd	3rd	4th	5th	6th	Tip
Base	55.0	17.5	10.0	0.0	27.8	0.0	42.5
Middle	27.9	4.8	0.0	4.8	0.0	0.0	26.9
Tip	44.1	6.8	11.8	8.6	4.35	20.0	40.2
All	39.6	7.74	6.5	5.44	4.17	2.5	35.0

Table 36 shows that the abortiveness is chiefly at the base and tip, the percentage being somewhat greater at the base. For intermediate position the amount decreases quite uniformly from the place next to the base, to the place next to the tip.

The instances were too few for the satisfactory determination of the relation of the weight of the seeds to the position in the pod for each size of pod, for both those with and those without abortiveness.

The results indicate that the first pods to form upon pea vines of the Alaska type are with a larger number of ovules than are those formed later, but the middle section produces the largest number of the pods and the heaviest seeds, with far the lowest percentage of abortiveness.

The abortiveness is chiefly in the basal and tip positions of the pods.

A STUDY OF ENVIRONMENT IN SMALL GRAINS BEGUN

A beginning has been made with small grains in the study of the influence of the position of the grain upon the plant (in the spike, etc.) upon the viability of the grain and the vigor of the seedling. At the same time that home-grown stock was being obtained, a test was made of the effect of depth of planting upon the weight of the plants produced. Some results also were obtained as to the effect of the number of plants to a hill upon the plant-weight. Ten hills, with 5 grains to the hill, were planted for each depth.

The results for wheat regarding depth of planting are given in table 37.

Depth Planted	No. of Plants	Average Weight gm.	Viability per cent
1 inch	13	77.5	26.0
2 inches	17	68.5	34.0
3 inches	22	81.4	44.0
4 inches	8	84.0	16.0
6 inches	9	99.5	18.0

The table shows that the viability was unfortunately low for all depths, but that the greatest was for the 3-inch depth.

Table 38

Average Weights of Plants for Each Depth

WEIGHT

	1 inch	2 inches	3 inches	4 inches	5 inches
Subject	gm.	gm.	gm.	gm.	gm.
Wheat	77.5	65.8	81.4	84.0	9.5
Oats	261.3	165.1	176.8	268.8	280.0
Barley	116.9	136.7	96.0	144.0	112.0
Buckwheat	39.5	48.0	35.3	68.1	49.7
Total	495.2	415.6	389.5	564.9	641.2

Table 38 shows that the greater depths give the greater weights.

Table 39

Percentage of Plants Harvested

Subject	1 inch per cent	2 inches per cent	3 inches per cent	4 inches per cent	5 inches per cent
Wheat	13	17	22	8	9
Oats	12	19	19	15	8
Barley	23	17	21	14	21
Buckwheat	17	14	19	23	18
Totals	65	67	81	60	39
Per cent	32.5	33.5	40.5	30.0	19.5

Table 39 shows that the viability rises from the 1- to the 3-inch depth and then declines to the maximum depth.

Table 40

Average Weight of Plant as Regards Number of Grains to Hill

Subject	1 Grain	3 Grains	5 Grains	10 Grains	20 Grains
	gm.	gm.	gm.	gm.	gm.
Wheat	74.6	58.9	85.3	53.3	43.2
Oats	410.6	168.0	175.0	197.6	62.6
Barley	149.6	120.6	136.9	71.6	46.6
Buckwheat	56.0	61.1	70.7	37.3	98.8
Totals	690.5	408.5	467.9	359.8	251.3

THE BREEDING OF VEGETABLE FRUITS

EARLE J. OWEN

I. Breeding of Beans

BLACK VALENTINE UPON DAVIS WAX (45-112). This combination of the wax variety with a green-podded kind gives in the F_1 the usual striped green pod and mottled or "mosaic" seeds. In the F_2 four distinct colors of pods are easily distinguished, the wax and green parental colors, the F_1 striped green and the striped wax. There are 4 seed colors, namely: black, white, F_1 mottled, and light mottled, the last breeding true.

DWARF HORTICULTURAL UPON PENCIL POD WAX (19-197). This is another union between a wax variety and a green-podded kind, both parents having a round springless pod. As with 45-112, the F_1 pod is striped green and the seeds mottled. In the F_2 there are 4 types of pods: wax, green, striped wax and striped green. The striped pods bear *mottled pods.*

HODSON WAX UPON KENTUCKY WONDER (185-260). This cross between a bush wax variety and a green-podded pole kind is giving a most promising pole-wax cross of high productiveness.

SCARLET RUNNER UPON REFUGEE WAX (63-132). This hybrid has been carried to the fourth generation. The following percentages are results that have been derived from 226 plants. The seeds have not been classified.

Table 40 shows that the weight of the plant was greatest when the grains were planted singly in the hill, and with one exception the weight decreased as the number of plants in the hill increased.

The low viability of the seed disturbed the experiment. This failure of a good stand was greatest with the largest number of seeds to the hill, as shown in the following averages from 1 seed to 20 seeds per hill, respectively, namely: 45.0 per cent, 54.2 per cent, 51.0 per cent, 69.5 per cent and 74.2 per cent.

It is seen that the factor of aerial environment as well as that of the depth of planting has a marked influence upon the weight of the plants at maturity. Soil space and air space are always to be reckoned with in field experiments.

Type of Plant	Per Cent	Type of Flower	Per Cent	Type of Pod	Per Cent
Pole	26	White	18	Green	36
Intermediate	58	Crimson	42	Striped	45
Bush	16	Pink	40	Wax	19

Contrary to the rule with *Phaseolus vulgaris* crosses, the white flower is not always associated with white seed. The Refugee Wax has a deep pink flower and yet in the union with the Scarlet Runner there are 18 per cent of the hybrid plants with white blossoms.

II. Breeding Eggplants

The study in inheritance in eggplants was continued with several crosses and hybrids. In the table following some of the results with the crosses are given.

Table 41

Subjects	Number of Plants	Color of Fruits Purple	Green	"Ivory" 6
Black Beauty upon 41 F_1	10	10		
Black Beauty upon 41 F_2	35	29	6	
New York Improved upon Round White F_1	5	5		
New York Improved upon Round White F_2	10	5	4	1
12 upon Long Purple F_1	5	5		
12 upon Long Purple F_2	10	6	4	

Table 41 shows that the purple color is fully dominant and that in the F_2 the green color is much in evidence.

Table 42

Results of Crossing Eggplants

Subjects	Number of Plants	Color of Fruits
New York Improved upon Scarlet Chinese F_1	10	no fruits
Striped upon Scarlet Chinese F_1	10	no fruits
Scarlet Chinese upon Round Purple F_1	5	no fruits
Hybrid upon Scarlet Chinese F_1	5	scarlet

Table 42 shows that all the F_1 hybrids were barren except in the last set, and here only two plants bore fruits.

The Dwarf Purple has been bred reciprocally with the scarlet Chinese and some of the results are given in table 43.

Table 43

Reciprocal Hybrids

Subjects	Number of Plants	Type of Plant Standard	Dwarf	Plant-Color Purple	Green
Dwarf Purple upon Scarlet Chinese	19	16	3	11	8
Scarlet Chinese upon Dwarf Purple	12	10	2	6	6

The small number of instances does not permit of any opinion as to the influence of the direction of the union upon the characters under consideration.

III. Breeding Muskmelons

The breeding of muskmelons was extended into the second generation by growing a plot of the cross of Burrell Gem upon Henderson Bush from seeds of three selected F_1 fruits. Both parental varieties were present with their offspring, and the numbers of fruits for the five sets of plants are given in table 44.

Table 44

Results of Breeding Muskmelons

Variety or Cross	Number of fruits	Average Weight gm	Average Length mm.	Average Width mm	No. with Salmon Flesh	No. with Intermediate Flesh	No. with Green Flesh
Burrell Gem	23	457.5	104.3	77.9	23	..	..
Henderson Bush...	21	183.8	56.9	66.7	..	..	21
Selection 1........	35	346.3	75.9	85.1	..	31	4
Selection 2........	41	287.4	76.5	74.2	21	5	15
Selection 3........	20	342.2	77.1	85.6	..	9	..

The mean of the weight of parent fruits (320.7 gm.) is very close to the average fruit weights (325.0 gm.) of the three groups of the F_2. In like manner the mean length (80.6 mm.) of the parental fruits is but little different from that (76.5 mm.) for the F_2 offspring. The mean width (72.3 mm.) of the parental fruits is less than that of F_2 (81.6 mm.)

The record for fruit-flesh color shows great differences among the offspring of the three fruits, and indicates that they all carried factors for both salmon and green flesh. Somewhat less than a third were with green flesh.

There were 58 bush plants among the 215 representatives of the F_2; they produced a low average number of fruits and these were much smaller and of a poorer quality than the melons from the vine plants.

IV. Reciprocal Tomato Crosses

True reciprocals of the Dandy Dwarf with Yellow Cherry are now in the second generation, but it is too soon after the harvest to more than make a fragmentary report of the results. The Dandy Dwarf, as its name suggests, is a dwarf and is somewhat exceptional in having yellow foliage and coarse leaves. The fruit is red and of medium size. The Yellow Cherry is a standard variety with ordinary green foliage and finely divided leaves. The fruit is red and small. Records were taken of all these contrasting characters of 159 of the Dandy Dwarf upon the Yellow Cherry plants, and of 158 of its reciprocal, that is, the Yellow Cherry upon the Dandy Dwarf. Five normal fruits of each plant were used for obtaining the average of the following characters: weight, length, width and number of locules. The color, whether red or yellow, also was recorded.

In the block of Dandy Dwarf upon Yellow Cherry there were only 22 dwarf plants, that is 13.8 per cent of the whole set. Table 45 shows the characters expressed in each plant.

Table 45

Dandy Dwarf upon Yellow Cherry

	Number of Plants	Foliage Green	Foliage Yellow	Leaves Fine	Leaves Coarse	Fruits Red	Fruits Yellow
	6	1		1		1	
	11	1		1			1
	15	1		1			1
	19	1		1			1
	20	1			1	1	
	30	1		1		1	
	36	1		1		1	
	37		1	1			1
	38	1		1		1	
	43	1			1	1	
	44	1		1		1	
	53	1		1		1	
	54	1		1		1	
	56		1		1	1	
	75	1		1			1
	105	1		1		1	
	110		1	1		1	
	111	1		1		1	
	127	1		1		1	
	142	1		1		1	
	150	1		1		1	
	161	1		1		1	
Totals ...	22	19	3	19	3	17	5

It is found that the percentages for the characters under consideration are:

Green foliage 86.4; fine leaves 86.4; red fruits 77.3.

Yellow foliage 13.6; coarse leaves 13.6; yellow fruits 22.7

It is seen that there is a wide deviation from the theoretical behavior of Mendelian characters in the color and type of the leaves.

The 27 dwarf plants (17.0 per cent) with their associated characters the reciprocal block, namely: Yellow Cherry upon Dandy Dwarf are listed in table 46.

Table 46

Yellow Cherry upon Dandy Dwarf

	Number of Plants	Foliage		Leaves		Fruits	
		Green	Yellow	Fine	Coarse	Red	Yellow
	12		1	1			1
	22	1		1		1	
	23	1		1		1	
	36	1			1		1
	40		1	1		1	
	45	1			1	1	
	46	1			1	1	
	54	1			1	1	
	58	1		1			1
	68		1		1	1	
	69	1			1		1
	70	1			1	1	
	73	1		1		1	
	77		1	1			1
	95	1		1		1	
	96	1		1			1
	115		1		1	1	
	117	1		1		1	
	128	1		1		1	
	140	1		1			1
	163		1		1	1	
	173	1		1		1	
	183	1			1		1
	184	1		1		1	
	188	1		1		1	
	189	1		1			1
	190	1			1	1	
Totals ...	27	21	6	16	11	18	9

It is found that the percentages for the characters under consideration are:

Green foliage 77.7; fine leaves 59.3; red fruits 66.6.

Yellow foliage 22.3; coarse leaves 40.7; yellow fruits 33.4.

A comparison of the percentages for this reciprocal cross is shown in table 47.

Table 47

Comparison of Reciprocal Crosses

	Foliage		Leaves		Fruits	
	Green	Yellow	Fine	Coarse	Red	Yellow
	%	%	%	%	%	%
Dandy Dwarf upon Yellow Cherry....	86.4	13.6	86.4	13.6	77.3	22.7
Yellow Cherry upon Dandy Dwarf....	77.7	22.3	59.3	40.7	66.6	33.4
Averages......................	*81.6*	*18.4*	*71.5*	*28.5*	*71.5*	*28.5*

This table shows that the green foliage and fine leaves are largely in excess of theory when the parent having these characters is the mother, and contrariwise, the coarse foliage is remarkably in evidence when the parent with that character is the mother.

When all the 49 plants are averaged the deviation from the theoretical is not beyond expectation for so few instances. However, any suggestions that may arise from these results as, for example, that the characters of the mother are more potent than of the pollen parent, must be held open for further expansion of the test through a detailed study of the full records for the whole 317 plants.

POSITION IN THE POD AND PRODUCTIVENESS; SEED WEIGHT AND ABORTIVENESS: PEANUTS

ORVILLE C. SCHULTZ

A block of the experiment area was planted with Tennessee peanuts in rows of ten hills each, in the following manner:

Row 1. Seeds from one-seeded pods.
Row 2. Seeds from the basal end of 2-seeded pods.
Row 3. Seeds from the tip end of 2-seeded pods.
Row 4. Seeds from the basal end of 3-seeded pods.
Row 5. Seeds from the middle of 3-seeded pods.
Row 6. Seeds from the tip end of 3-seeded pods.
Row 7. Seeds from the basal end of 4-seeded pods.
Row 8. Seeds from the 1st middle of 4-seeded pods.
Row 9. Seeds from the 2nd middle of 4-seeded pods.
Row 10. Seeds from the tip middle of 4-seeded pods.

The harvest was made row by row and the fruits assorted into five groups as to the number of ovules in a pod and the weights of the seeds taken and the amount of abortiveness recorded.

The harvest of the ten rows (100 hills) is given in table 48 with the total number of pods and for each type.

Table 48

Number of Peanut Pods of Various Types

Position of Seeds planted	Number of Pods	Type of Pod in Harvest 1-ov.	2-ov.	3-ov.	4-ov.	5-ov.	Possible Seeds
Row 1. One-seeded pods.......	426	40	170	199	80	0	1297
Row 2. Two-seeded pods base..	289	14	60	166	49	0	828
Row 3. Two-seeded pods tip...	371	41	85	182	61	2	1011
Row 4. Three-seeded pods base.	385	24	60	191	108	2	1159
Row 5. Three-seeded pods middle	409	16	57	202	134	0	1272
Row 6. Three-seeded pods tip..	283	13	29	128	110	3	910
Row 7. Four-seeded pods base..	270	15	35	126	91	3	842
Row 8. Four-seeded pods 1st middle	227	7	29	101	89	1	729
Row 9. Four-seeded pods 2nd middle	373	20	62	169	121	1	1140
Row 10. Four-seeded pods tip...	385	8	66	183	125	3	1204
Totals	3418	198	653	1647	968	15	10392
Number of ovules.........	10392	198	1306	4941	3872	75	

Table 48 shows that the average number of seeds to a pod is close to three, the actual average being 3.03.

The number of pods and their types are given in table 49 for each *type employed in planting.*

Table 49

Number of Pods of Peanuts Harvested for Each Type Employed in Planting

Type of Pod for planting	Number of Pods	1-ov.	Type of Pod in the Harvest 2-ov.	3-ov.	4-ov.	5-ov.
1-seeded	426	40	170	199	80	0
2-seeded	660	55	145	348	110	2
3-seeded	1077	53	146	521	352	5
4-seeded	1255	50	192	579	426	8
Totals..............	3418	198	653	1647	968	15

It is important to bring all types in table 49 to the same basis by taking averages for mother pods (when more than 1-seeded) and this gives the comparable results shown in table 50.

Table 50

Number of Pods of Peanuts Harvested for Each Type of Mother Pod

Mother Pod	Average Number	1-ov.	2-ov.	3-ov.	4-ov.	5-ov.
1-seeded	426.0	40.0	107.0	199.0	80.0	0.0
2-seeded	330.0	27.5	72.5	174.0	55.0	1.0
3-seeded	359.0	17.7	48.7	173.7	117.3	1.7
4-seeded	313.7	12.5	48.0	144.8	106.5	2.0

The table shows that the seeds from 1-seeded pods, gave the largest yield, and the seeds from 4-seeded pods the smallest crop. It is further shown that seeds from 1-seeded pods yield the largest number of 1-ovuled pods and the number of this type decreases rapidly as the number of seeds in the parent pod increases.

The details are shown in percentages in table 51.

Table 51

Percentages of Different Types of Pods

Type of Pod for planting	Type of Pod in Harvest 1-ov.	2-ov.	3-ov.	4-ov.	5-ov.
1-seeded	9.3	25.1	46.8	18.8	0.0
2-seeded	8.3	21.9	52.8	16.7	0.3
3-seeded	4.9	13.6	48.3	32.7	0.5
4-seeded	3.9	15.3	46.3	33.9	0.6

Table 51 shows that the percentages of both the 1- and the 2-ovuled pods are comparatively high for seeds from 1-ovuled pods, and the percentages of 4- and 5-ovuled pods comparatively high for plants from 4-ovuled pods. These results suggest that there is a possible causal relationship between type of mother pod and that of the offspring.

The average weights of the seeds for position in the pod are given in table 52.

Table 52

Average Weights of Seeds for Different Positions in Pod

Position	Weight gm.	Rank	Weight by Pod gm.	Rank by Pod
1-seeded	.500	1	.500	1
2-seeded base	.497	2	.473	3
2-seeded tip	.449	10		
3-seeded base	.490	4		
3-seeded middle	.491	3	.480	2
3-seeded tip	.458	9		
4-seeded base	.473	5		
4-seeded 1st middle	.473	6		
4-seeded 2nd middle	.466	7	.470	4
4-seeded tip	.467	8		

The table shows that the seeds of 1-ovuled pods are the heaviest, followed by the basal seeds of 2-ovuled pods, the middle and basal seeds of 3-ovuled pods and then the basal and lower middle of 4-ovuled pods. In other words, the basal half of all pods carries the heaviest seeds. On the other hand, the lightest seeds are at the tip of the 2-ovuled pods, next heavier at the tip of 3-ovuled pods, followed by those in the upper half of 4-ovuled pods. The average weights for pods show that the seeds of 3-ovuled pods are heavier than those of 2-ovuled pods, and the lowest average is for the seeds in 4-ovuled pods.

The amount of abortiveness in peanuts is shown in table 53 in percentages for each position in each type of pod.

Table 53

Abortiveness in Peanuts for Each Type of Pod

	Per Cent of Abortiveness	Per Cent for Pod Type
1-ovuled pods	11.61	11.61
2-ovuled base	36.95	
2-ovuled tip	23.73	30.34
3-ovuled base	32.54	
3-ovuled middle	21.43	
3-ovuled tip	22.22	25.39
4-ovuled base	41.94	
4-ovuled 1st middle	16.32	
4-ovuled 2nd middle	16.12	
4-ovuled tip	16.22	22.68
5-ovuled base	60.00	
5-ovuled 1st middle	13.33	
5-ovuled 2nd middle	26.66	
5-ovuled 3rd middle	20.00	
5-ovuled tip	20.00	28.00

It is shown that the lowest percentage of failure of ovule development is in the 1-ovuled pods, while the highest is in the base of 5-ovuled pods. The average of all four basal sets is 48.88 per cent; of the middle sets 18.98 per cent and of the tip sets 20.54 per cent. This shows that far the greatest amount of abortiveness is in the basal position, and that it is somewhat greater at the tip than in the middle region of the pod. When the type of pod is the basis it is shown that the greatest percentage of failures in seed-formation is in the 2-ovuled pods and the amount decreases through the 3-ovuled and 4-ovuled pods, and rises slightly in the 5-ovuled pods, due to the excessive abortiveness in the basal position.

Summary

The results given above suggest that seeds from 1-seeded pods may yield the largest number of pods, and the seeds from 4-seeded pods the smallest crop. It is further shown that the seeds from 1-seeded pods yielded the largest percentage of 1-seeded pods, and this percentage decreases as the number in the parent pods increases. This result suggests that there is a possible inheritance of pod type.

The seeds of 1-ovuled pods are the heaviest of all and the basal halves of all other pods bear heavier seeds than the upper halves. The 4-ovuled pods average the lightest seeds (the number of 5-ovuled pods being too few to be considered). All basal seeds average much heavier than the tip seeds.

Abortiveness is lowest in 1-ovuled pods and highest at the base of all other pods, the percentage increasing from that in 2-ovuled pods to that in 5-ovuled pods, where it is 60 per cent.

There is a positive correlation between size of seeds and amount of abortiveness, that is, the basal position in all pods yields the larger seeds and the greater amount of abortiveness, both these results depending upon the position of the ovules.

REPORT OF PROGRESS IN PLANT PHYSIOLOGY

Under the project of Toxicology several lines of research were pursued during the year. Brief abstracts of the principal ones of these researches, together with the names of the persons by whom the work was carried out, are given below.

I. THE TOXICITY OF PHOSPHATES TOWARD SOYBEAN SEEDLINGS

JOHN W. SHIVE

The studies of the influence of the monobasic phosphate salts on the growth of soybeans, which were begun last year, were continued during a part of this year. An outline of the methods employed in these experi-
part of this year. An outline of the methods employed in these experi-
ments, the preparation of the culture media, the method of applying the solutions to the soil-sand cultures, the method of germinating the seeds, and the subsequent treatment of the plants, was included in last year's report and need not be repeated here. The data obtained from these experiments are now ready for publication, but a brief summary of the main results of these tests is here presented.

I. Monobasic Phosphate Salts Used Singly in Soil Cultures.

The five phosphates, NaH_2PO_4, $(NH_4)H_2PO_4$, KH_2PO_4, $CaH_4(PO_4)_2$ and MgH_4 $(PO_4)_2$, in the form of solutions with osmotic concentrations varying from 0.5 atmospheres to 7.0 atmospheres, were applied singly to soil cultures. The total salt added to each culture was included in a single initial application of 500 cc. of solution to each 1000 gm. of soil. Five groups of cultures corresponding to the five phosphates were employed. Each group comprised 11 cultures, including one check culture without salt. The cultures were conducted during a growth period of 39 days.

1. As indicated by relative yields, the growth of soybean tops was unfavorably influenced by each of the five monobasic phosphate salts employed singly in soil cultures. The average yield from the check cultures was considerably higher than the highest yield from any treated culture. Relative to the average yield from the check cultures considered as 1.00, the highest yields from the five groups of cultures corresponding to the five salts employed, were as follows: Group I [NaH_2PO_4], 0.86; Group II [$(NH_4)H_2PO_4$], 0.80; Group III [KH_2PO_4], 0.94; Group IV [$CaH_4(PO_4)_2$], 0.81; and Group V [$MgH_4(PO_4)_2$], 0.85.

2. Each of the phosphate salts used singly in soil cultures produced a diseased condition of the soybean plants, resulting in specific injury, with all except very low applications (solutions with osmotic values of .5 atmospheres to 1.5 atmospheres, applied in quantities of 500 cc. to 1000 gm. of air-dry soil.)

3. With respect to their capacities for producing the specific injury when used singly in soil cultures, the phosphates employed arrange

themselves in the following order, beginning with the salt showing the lowest capacity for producing the injury: KH_2PO_4 $(NH_4)H_2PO_4$, $MgH_4(PO_4)_2$, NaH_2PO_4, and $CaH_4(PO_4)_2$.

4. Careful comparison of the injured plants showed the nature of the injury produced by the various phosphates to be identical. This leads to the conclusion that the injury cannot be attributed to the influence of the cations, but must be directly related to some property which is common to all of these salts in solution: that is, to the common atomic group H_2PO_4. or to the ions resulting from the dissociation of this group in the soil solution.

II. Monobasic Phosphate Salts in Soil Cultures with Complete *Nutrient Mixtures*

The salts were applied to the soil cultures in the form of mixed solutions with *equal total osmotic concentrations* (2.5 *atm.*). Each solution contained, in addition to one of the five phosphates, the three salts, KH_2PO_4, $Ca(NO_3)_2$, and Mg SO_4. These were present in corresponding solutions of five series in the same volume-molecular and osmotic proportions. A control series of solutions with only KH_2PO_4,$Ca(NO_3)_2$, and $MgSO_4$ was also employed. Each group comprised 21 cultures (including one check without salt) employing 20 different sets of salt proportions. The total salts added to each culture were included in a single initial application of 500 cc. of solution to each 4000 gm. of soil. The cultures were conducted during a growth period of 30 days.

1. Out of a total of 20 sets of salt proportions of the three salts, KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$ (employed as a control series of complete nutrient mixtures to which the phosphates were added singly to form 5 different groups of cultures) 17 improved the soil cultures for the growth of soybeans, as compared with the growth in the check cultures to which no salts were added, and 3 proved harmful. The maximum yield from the control series was 61 per cent higher than the average yield from the check cultures. The minimum yield was 3 per cent below the average yield from the checks. The salt proportions of the solutions added to the cultures of this group producing maximum and minimum yields are: KH_2PO_4, 0.0173m; $Ca(NO_3)_2$, 0.0040m; and $MgSO_4$, 0.0322m, for the former, and KH_2PO_4, 0.0074m; $Ca(NO_3)_2$, 0.0257m; and $MgSO_4$, 0.0083m, for the latter.

2. Many degrees of beneficial and some injurious effects upon the growth of soybeans may be obtained by the application of various proportions of the three salts, when the total quantities of the three salts in solution applied to the soil cultures have approximately equal osmotic values. That the physiological balance of salt proportions in nutrient media such as were here employed is markedly dependent upon total concentration, has frequently been pointed out. This emphasizes the importance of considering not only salt proportions but also total quantities applied (concentration) in the use of fertilizer salts in agricultural practices.*

3. The five groups of cultures, each employing a single phosphate in connection with the salts of the control group, produced their maximum yields in corresponding cultures of the different groups. The maximum yields from these five groups of cultures, relative to the average yield from the check cultures considered as 1.00, are as follows: Group I [NaH_2PO_4], 1.60; Group II [$(NH_4)H_2PO_4$], 1.51; Group III [KH_2PO_4], 1.49; Group IV [$CaH_4(PO_4)_2$], 1.63; and Group V [$MgH_4(PO_4)_2$], 1.39 The maximum yield from the control group has a corresponding value of 1.61, which is slightly surpassed only by the maximum yield from Group IV, having a value of 1.63.

4. No specific injury was sustained by any of the cultures of the control group containing the three salts KH_2PO_4, $Ca(NO_3)_2$ and $MgSO_4$.

5. A number of cultures from each of the five groups employing a phosphate in connection with the three salts KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$, suffered pronounced injury but in no culture was the injury sufficiently severe to cause the death of the plants before the end of the growth period. The five groups of cultures arranged according to the increasing order of the total amounts of injury sustained (or according to the increasing order of the severity of the injury) are: Group III [KH_2PO_4], Group II [$(NH_4)H_2PO_4$], Group V [$MgH_4(PO_4)_2$], Group I, [NaH_2PO_4], and Group IV [$CaH_4(PO_4)_2$].

6. In all the groups except the one (IV) employing $CaH_4(PO_4)_2$, the injury was confined to those cultures each of which had received an application of solution whose partial osmotic concentration due to the total phosphates in the solution was not less than six-tenths of the total osmotic concentration (2.5 atm.) of the solution. In the group (IV) employing $CaH_2(PO_4)_2$ injury was observed in cultures prepared with solutions whose partial osmotic concentrations due to total phosphates was as low as four-tenths of the total concentration of the solution.

7. The degree of injury (slight, pronounced, and severe) sustained by the cultures of the five groups was not determined solely by the total phosphate content of the medium in which the plants were grown, but was largely influenced also by the relative proportions of the four salts.

8. There is no clearly definite relation between injury and yields. In a general way pronounced injury is coincident with relatively low yields. Slight injury has no greater tendency to occur with low yields than with high yields, and does not interfere materially with the production of high yields.

III. Monobasic Phosphate Salts in Solution Cultures with Complete Nutrient Mixtures

The solutions used for water cultures in this experiment were the same as those employed in the preparation of the soil cultures of the preceding experiment (II). Five hundred cubic centimeters of solution was used for each culture and the solutions were renewed every third day. The cultures extended over a growth period of 24 days.

1. The maximum yield from the control group of cultures, employing the salts KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$, was not equaled by the maxi-

mum yield from any of the other groups of cultures. The maximum yield from this group, relative to the average yield from Knop's solution (used as a check) taken as 1.00, was 1.54, and was produced by a solution having the salt proportions as follows: KH_2PO_4, 0.0058m; $Ca(NO_3)_2$, 0.0120m; and $MgSO_4$, 0.0323m. The maximum relative yields from the other groups are: Group I [NaH_2PO_4], 1.46; Group II [$(NH_4)H_2PO_4$], 1.43; Group III [KH_2PO_4], 1.17, and Group V [$MgH_4(PO_4)_2$], 0.66.

2. The cultures of Groups I and II, employing NaH_2PO_4 and $(NH_4)H_2PO_4$, respectively, in connection with the three salts of the control group, produced markedly higher yields throughout than did the corresponding cultures of Groups III and V, similarly employing KH_2PO_4 and $MgH_4(PO_4)_2$, respectively.

3. The solutions (Group IV) employing $CaH_4(PO_4)_2$ in connection with the three salts KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$, were entirely unsuited to the growth of soybeans, owing to the extreme toxicity produced by the introduction of the mono-calcium phosphate into the solutions.

The total injury sustained by the cultures of each group was much more severe than that sustained by the soil cultures of the corresponding groups, when judged by the same standards. The arrangement of the groups of solution cultures according to the increasing order of the total amounts of injury sustained is not the same as that of the corresponding groups of soil cultures. The order is as follows: Group I [NaH_2PO_4], Group II [$(NH_4)H_2PO_4$], Group III [KH_2PO_4], Group V [$MgH_4(PO_4)_2$], and Group IV [$CaH_4(PO_4)_2$].

4. *In each group (except Group IV employing $CaH_4(PO_4)_2$ injury* was produced by the solutions whose partial osmotic concentrations due to the total phosphate was not below four-tenths of the total osmotic concentrations (2.5 atm.) of the solutions.

5. The degree of injury sustained by the plants is not due alone to the total phosphate content of the solutions, but is related also to the proportions of the salts.

6. A definitely clear relation exists between yields and injury: high and medium yields were obtained from cultures which suffered no injury, while low yields were coincident with pronounced injury.

7. The *acid content of the solutions of the control group employing* the three salts KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$, bears a definite relation to the injury sustained by the plants: the higher the acid content of the solutions (as this was here determined by means of titration methods) above a certain value which marks the limit of injury production with this series of solutions, the greater is the degree of injury suffered by the plants. This relation is not absolutely definite for the other groups of solution cultures here employed. The relative salt proportions play a very important role in either accentuating or diminishing the injury sustained by the plants, when the acid content of the solutions is sufficiently high to produce the injury.

II. COMPARISON OF SALT REQUIREMENTS FOR YOUNG AND FOR MATURE BUCKWHEAT PLANTS GROWN IN SAND CULTURES

JOHN W. SHIVE

During the year an attempt was made to determine whether the salt combinations required to produce good plant growth during the early stages of development are also adequate to maintain equally good growth during the maturing stages of the plant, and to produce good crop yields. The present announcement aims to state the results of these experiments in a preliminary way and to describe in a brief manner the methods employed.

The work was carried out with buckwheat (*Fagopyrum esculentum* Moensch.) in sand cultures. Salts were applied to the sand in the form of solutions of the same initial total concentration, but varying in the proportions of the component salts. An initial total concentration with an osmotic value of 1.75 atmospheres was employed with a series of 36 different salt proportions of the three component salts, KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$. This series included all the possible sets of salt combinations when each of the three components was made to vary by increments equal to one-tenth of the total osmotic concentration (1.75 atm.) The culture vessels consisted of glazed earthenware pots, each of which held 2500 gm. of dry sand when filled to within about 3 cm. of the top. Each culture consisted of 5 plants growing in quartz sand which had previously been washed, first with tap water and then several times with distilled water.

The buckwheat seeds were soaked in water for several hours and were then germinated on a germinating net. When the seedlings were about 4 cm. tall, those carefully selected for uniformity were transferred to the pots of sand, which had been previously prepared in such a way as to provide for the renewal of the nutrient solutions in the sand at regular intervals during the growth period.

The solutions were renewed every third or fourth day. This was accomplished by a method which is a modification of that adopted by McCall in his study of physiological balance of nutrient solutions for plants in sand cultures. The diagram of figure 1 represents a longitudinal section through a diameter of the pot and gives the essential features of the culture vessels here employed. To provide for the removal of the solutions a glass tube (A) extends to the bottom of the pot. The outlet of this tube at the bottom is screened by means of a plug (B) of glass wool which prevents the escape of any grains of sand when suction is applied to the top of the tube. After 2500 gm. of dry sand have been weighed into the pot, the funnel (C), made of heavy paper and thoroughly impregnated with melted paraffine to render it impervious to moisture, is placed in position at the center of the pot with its lower portion buried in the sand to the depth of about 1 cm. The upper opening of the funnel is kept tightly closed by means of a paraffined cork stopper (D), except for the short period of time re-

To prepare the sand in each pot for the planting of the seedlings, the nutrient solution was poured into the funnel until the sand was nearly saturated. The seedlings were then planted, five to each pot, after which a sufficient amount of the solution was added through the funnel to flood the culture until the free solution stood above the sand to a depth of 1 cm. or more. This served to fix the roots of the seedlings in place and to smooth the surface of the sand. Seven hundred and fifty cubic centimeters of solution was added to the sand of each culture with this initial application. Suction was then applied to the tube A by means of a filter pump and the withdrawal of the solution

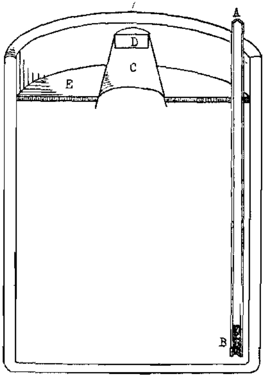

Fig. 1. Diagram showing principal features of culture vessel, (A) glass tube for removal of solutions, (B) plug of glass wool, (C) paraffined paper funnel, closed by paraffined cork stopper (D), (E) wax seal.

was continued until the sand had been reduced to the desired moisture content, which throughout this work was maintained at approximately 15 per cent of the dry weight of the sand, or 60 per cent of its water-holding capacity. The culture was now ready to be sealed, which was done by pouring over the surface a thin layer (E) of melted paraffine wax (prepared according to the formula of Briggs and Schantz), completely covering the sand between the walls of the pot and the funnel.

At the end of each three or four-day period each pot was weighed and a sufficient amount of distilled water added through the funnel to restore it to its original weight, after which a fresh nutrient solution was added (250 cc. to each culture) and an equal quantity of solution withdrawn through the tube A. During the later stages of growth the pots were weighed daily and their original weight restored by the ad-

dition of distilled water, but the solutions were renewed only every third or fourth day. A record was made of the amounts of water added at each weighing, and the summation of these for the entire growth period gave, of course, the total transpirational water loss from the plants of the culture in question.

At the end of the growth period the wax seal was removed and the tops of the plants were severed from the roots at the surface of the sand. The tops were then dried to constant weight in the electric oven at a temperature of about 104°C., and the dry yields obtained. In order to wash the roots as free from sand as possible, the contents of each culture pot were carefully transferred to a sieve sufficiently coarse to allow all the sand grains to pass through it. The sand was then washed through the sieve by means of a gentle stream of water, leaving the roots on the sieve. The roots, with some adhering sand grains, were dried to constant weight in the same manner as were the tops. The dried roots, together with the adhering sand, were weighed, after which the roots were ignited in porcelain crucibles until all the organic matter had been destroyed. The loss in weight due to this ignition was here taken to represent the dry weight of the roots.

The first series of 36 cultures was continued until the plants were in bloom, in order to determine the fertilizer combination required to produce the best growth of buckwheat tops and roots in sand cultures, with renewed solutions, for this early physiological stage of development. This required a time period of 25 days after the seedlings had been transferred to the sand cultures. The series was then repeated, and the data here given represent averages from two series, one conducted in April and the other in June. For the purpose of comparison, there were added to each series two control cultures prepared with Knop's solution and Tottingham's best solution for wheat tops, all with total concentrations equal to each of the 36 solutions of the series (osmotic value 1.75 atm.))

The highest average yield of buckwheat tops with these series was obtained from a culture in which the salts were present in the following volume-molecular proportions: KH_2PO_4, 0.0144m; $Ca(NO_3)_2$, 0.0052m; $MgSO_4$, 0.0200m. The average yield from this culture showed an improvement of 38 per cent over that from the culture prepared with Knop's solution, and a corresponding improvement of 25 per cent over the average yield from the culture containing Tottingham's best solution for wheat. The two corresponding series agreed in the proportions of the salts producing the highest yield of tops, but they did not agree in the proportions of the salts which produced maximum root yields.

The corresponding cultures of the two series giving the average maximum yield of roots, contained the three salts in the following volume-molecular proportions: KH_2PO_4, 0.0180m; $Ca(NO_3)_2$, 0.0104m; $MgSO_4$, 0.0050m. This showed an improvement over the yields from the cultures with Knop's solution and with Tottingham's solution for wheat, of 47 per cent and 16 per cent, respectively. It is thus seen that the

highest average root yield was not produced by the same set of salt proportions which produced the highest average yield of tops. There was no apparent correlation between the yields of tops and roots for these two series of sand cultures during the earlier stages of development.

In order to determine the salt proportions required to produce the best growth of buckwheat tops from the flowering stage to the maturing of the seed, the following procedure was adopted: 38 sand cultures (including two for controls) were prepared as previously described, all with the same solution. This solution had the salt proportions above given, which produced the highest yield of buckwheat tops during the earlier period of growth up to the flowering stage. Thus all the plants were grown in the same culture medium, with the same salt proportions, during this first 25-day growth period. The solutions were renewed every third or fourth day and the cultures were conducted in precisely the same manner as before. At the end of this time period the plants throughout the series showed exceptional uniformity.

The solutions in the sand cultures were now replaced by the 36 different solutions of the 3-salt series (employed with the previous series), including all the possible sets of salt proportions, for increments of variation in the component salts equal to one-tenth of the total osmotic concentration (1.75 atm.) This was accomplished by passing through the sand of each culture a triple portion (750 c.c.) of the new solution, thus flushing out the old solution and replacing it with the new. The solutions in the control cultures were replaced, one with Knop's solution, the other with Tottingham's best solution for wheat.

The series was now conducted with renewal of solutions as before, until the seed was mature. This second growth period extended over a time interval of 30 days. The series was then repeated. The first of these two series was conducted from April 25 to June 19. The second series, which was just like the first, was carried out between July 2 and August 27. At the end of the second growth period of each series, the dry weights of tops, roots, and seeds were obtained separately in the same manner as were the yields of the two preceding series.

The highest average yield of tops, of roots, and of seed with these series was obtained from the same culture. The solution of this culture contained the three salts in the following volume-molecular proportions: KH_2PO_4, 0.0108m; $Ca(NO_3)_2$, 0.0130m; $MgSO_4$, 0.0100m. The two corresponding series agreed in the proportions of the three salts giving the maximum yields of tops and of seeds, but they did not agree in the proportions of the salts which produced the highest dry weights of roots, although the highest *average* yield of roots occurred with the same culture producing the highest *average* yield of tops and seed. The highest average yield of tops from these series showed an improvement of 43 per cent and 45 per cent over the yields from the two controls with Knop's solution and with Tottingham's best solution for wheat, respectively. The maximum average yield of roots was 22 per cent higher

than the average yield from Knop's solution and 49 per cent higher than that from Tottingham's solution, while the maximum yield of seed showed a corresponding improvement of 25 per cent and 95 per cent over the average yields from Knop's solution and from Tottingham's best solution for wheat, respectively, employed as controls in sand cultures. For comparison, these results are presented in table 54, together with the corresponding data of the series representing the early period of growth from seed to flowering.

Table 54

Comparison of Buckwheat Yields and of Salt Proportions Required to Produce Best Growth for Two Different Physiological Periods of Development

		Partial volume-molecular concentrations			Maximum yield relative to that from Knop's solution taken as 1.00	Maximum yield relative to that from Tottingham's solution taken as 1.00
		KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$		
Buckwheat grown to flowering	Tops	0.0144	0.0052	0.0200	1.38	1.25
	Roots	0.0180	0.0104	0.0050	1.47	1.16
Buckwheat grown to maturity	Tops	0.0108	0.0130	0.0100	1.43	1.45
	Roots	0.0108	0.0130	0.0100	1.22	1.49
	Seeds	*0.0108*	*0.0130*	*0.0100*	*1.25*	*1.95*

From the above comparison it is at once clear that the salt proportions required to produce the best development of buckwheat tops and of roots during the earlier period of growth from seed to flowering are not at all the same as are those which give the best growth during the later period from flowering to maturity. It will be observed that for the best average yield of tops, with the later period of growth, a lower proportion of KH_2PO_4, a much higher proportion of $Ca(NO_3)_2$, and a lower proportion of $MgSO_4$ was required than for the best average yield of tops during the early period. For the production of the maximum average root yield during the later period of growth, the KH_2PO_4 requirement is lower, the $Ca(NO_3)_2$ requirement is higher, and the $MgSO_4$ requirement is much higher than for the earlier period of growth.

It is to be emphasized, of course, that the results here briefly outlined may possibly hold only for the particular sets of conditions under which these cultures were carried out. A markedly different set of climatic conditions from those here experienced, a more frequent renewal of solutions, or a different total concentration than the one here used (osmotic value 1.75 atm.), may possibly call for a different set of salt proportions to produce the highest yields of which these plants are capable, for each of the two periods of growth here considered.

III. THE INFLUENCE OF THE ROOTS OF GROWING PLANTS UPON THE ACTIVITY OF SOIL MICRO-ORGANISMS AS INDICATED BY THE PRODUCTION OF CARBON DIOXIDE FROM THE SOIL

J. R. NELLER

The possible influence of the roots of growing plants upon the rate of liberation of plant-food by soil microorganisms has so far been largely a matter of conjecture and theory. It is believed that some plants excrete poisonous substances and that others do not. If such be the case, certain crops might retard biological activity while others might have no effect or might even increase it, as some investigations indicate.

Table 55

The Production of Carbon Dioxide in Jars of Soil with Growing Plants and in those without Plants

		Pot I Buckwheat plants	Pot II Without plants	Pot III Barley plants	Pot IV Without plants
		mgm.	mgm.	mgm.	mgm.
CO_2 liberated	July 3 to 12	346.5	462.7	469.7	469.7
	July 12 to 20	220.9	387.4	227.2	385.7
	July 20 to 29	113.0	176.4	101.5	171.5
Total CO_2 liberated		680.4	1025.5	798.4	1026.9
CO_2 from carbon of plants*		604.0		361.5	
Total CO_2		1284.4	1025.5	1159.9	1026.9

In this work the problem was attacked by growing plants under bell jars through which carbon-dioxide-free air was aspirated. The carbon dioxide necessary for plant growth was derived from the decomposing organic matter in the soil or sand placed in a jar under the bell jars. The excess of carbon dioxide evolved was determined by drawing the outgoing air current through bead towers containing a solution of barium hydroxide. The amount of carbon dioxide used by the plants within the bell jars was found by determining the total carbon produced by the plants. Thus the total amount of carbon dioxide liberated was accounted for. The bell jars were used in pairs, the first one as described above and the second with all conditions similar to the first except that no plants were grown under it. The effect of the growing

*The total carbon of the seedlings planted was here considered equivalent to that of an equal number of similar seedlings, the total carbon of which was determined and deducted from the total carbon of the plants at the end of the experiment.

plants could then be studied by comparing the total carbon dioxide liberated in the two bell jars.

Barley and buckwheat plants were tested in the first series. They were grown in pure white sand moistened with a nutrient solution and containing 0.6 per cent of ground alfalfa hay as the source of carbon dioxide. The jars of sand were inoculated with an infusion from a rich neutral soil. Naturally, much more carbon dioxide was collected from the bell jars in which no plants were growing, but when the carbon dioxide that had been used by the plants was added, it was found that slightly more of the gas had been liberated from the bell jars containing plants than from those without plant growth (table 55).

In a second series, buckwheat was grown as a residual crop in the same jars of sand. Again, slightly more carbon dioxide was recovered from the bell jars containing plants than from the others (table 56). Thus it appears that under the conditions of the experiment, the growing roots of barley and buckwheat do not inhibit the decay of organic matter.

Table 56'

Production of Carbon Dioxide in Jars of Soil with and without Plants

		Pot I Buckwheat plants	Pot II Without plants	Pot III Buckwheat plants	Pot IV Without plants
		mgm.	mgm.	mgm.	mgm.
CO_2 *liberated*	*Aug. 1 to 10*	*261.8*	*395.5*	*165.9*	*397.1*
	Aug. 10 to 29	365.1	564.2	328.8	568.8
Total CO_2 liberated		626.7	959.7	494.7	947.9
CO_2 from carbon of plants		375.0		495.9	
Total CO_2		1001.9	959.7	990.9	947.9

It seems desirable to make other tests with other species of plants and to employ an acid or otherwise unfavorable soil medium, so that the influence of the growing roots could more easily tip the balance, so to speak, either favorably or unfavorably for the activity of the various species of soil micro-organisms. A comparison of the parallel effects of fertilizing elements and of stimulants upon plant growth and upon biological activity taking place in the same soil in which the roots are growing, could be conducted with an apparatus similar to the one used in the above work.

IV. EFFECT OF AMMONIUM SULFATE IN NUTRIENT SOLUTION ON THE GROWTH OF SOYBEANS IN SAND CULTURES

M. I. WOLKOFF

This experiment was performed in order to study the effect of ammoniacal nitrogen, in the form of sulfate in the Tottingham nutrient solution, on the yield of soybeans grown in sand cultures. The solutions of the series, which is designated as the ammonium sulfate series, employed the four salts: mono-potassium phosphate, calcium nitrate, ammonium sulfate, and magnesium sulfate. In parallel with this the unmodified Tottingham solutions were run as a control series. As is well known, Tottingham's nutrient solutions contain mono-potassium phosphate, calcium nitrate, potassium nitrate, and magnesium sulfate. In addition to this a trace of iron was supplied to every culture. The control series comprised 20 cultures chosen from the Tottingham series of 84 cultures in such a way as to be fairly representative of the entire series. The cultures of the ammonium sulfate series corresponded in every respect to those of the control series, except that the former employed ammonium sulfate where potassium nitrate was used in the latter. The total osmotic concentration of the nutrient solutions of both series was approximately 2.5 atmospheres. The soybeans employed were of the "Black Eyebrow" variety.

The plants were grown in sand cultures in glazed earthenware cylindrical pots that were 12.5 cm. in height and 10 cm. in the inside diameter. One thousand four hundred grams of sand, washed in distilled water and dried, were used in each pot. The water-holding capacity of the sand was 23.4 per cent. The moisture content of the sand cultures during the experiment was maintained practically constant at about 60 per cent of the water-holding capacity. The water was added from day to day through a paper funnel, prepared for the purpose, and inserted in the middle of the pot. This funnel was made from manilla paper rolled to make a cone, and dipped into melted parowax. Every three or four days the solution in the sand cultures was changed, which was accomplished by a method similar to that employed by McCall (Soil Sci., vol 2, 1916, No. 3, p. 207), the difference being in the design of the pots. Instead of drawing off the solution at the bottom, as was done by McCall, provision was made to withdraw the excess solution at the top by means of a glass tube which extended to the bottom of the pot. After planting the seedlings, which were germinated in special boxes containing moist sand, the surface of the sand in the pots was sealed with a mixture of parowax and vaseline. Three healthy seedlings of uniform size were used for each pot. Forty cultures, twenty of each of the two series, thus prepared, were begun on January 25, 1917, and continued to March 5, the total growing period in pots being 39 days. Later, the experiment was repeated, and was run from April 2 to May 11 of the same year, again making 39 days for the growth period.

In order to ascertain whether or not an appreciable adsorption of salts had taken place after adding the solutions of these salts to the sand, the concentration of solutions was determined both before and after adding them to the sand. Moreover, the concentration of the solutions in the sand cultures was also determined. This was done at three different times during the growth period: (1) at the beginning of the experiment, (2) 15 days after the start, and (3) at the end of the 39-day period of growth. A portion of the solution was withdrawn by means of suction from each of the sand cultures and was tested. In addition to this, the concentration of the solutions while in the sand, at the end of the experiment, also was determined. The determinations were made by means of the cryoscopic method.

Two very significant features were brought forth by these studies. One of these interesting observations lies in the fact that, with very few exceptions, the concentration values of the original solution in both series, sand treated with solution, all solutions obtained by suction from the culture pots, and, finally, of the solutions still in the sand at the end of the experiment, follow one another with striking consistency. There is no great difference between the concentration of the original solution and that of the solution in the sand cultures. Therefore, the difference in the plant growth from culture to culture could not be attributed to the power of adsorption to modify the total osmotic concentration of the nutrient solution in the sand.

Another outstanding feature of the results obtained in this preliminary study is the apparent tendency of the nutrient solution containing ammonium sulfate, when added to the sand, to become more concentrated than the original solution. In 15 cases out of twenty the freezing-point depression of the solution in sand was greater than that of the corresponding original solution. The behavior of the Tottingham solution was entirely different in this respect. In 19 cases out of twenty the concentration of the solution in sand was somewhat lower than the concentration of the solution before adding it to the sand. It seems that when sand or soil is treated with ammonium sulfate, the alkali radical, NH_4, is adsorbed by this solid phase more strongly than the acid radical, SO_4. As a result of this unequal adsorption an excess of the SO_4 ions is left in solution, and, uniting with H ions of slightly dissociated water, formed some free H_2SO_4. Since the dissociation of acid is greater than that of the original salt (ammonium sulfate) the freezing-point depression in the case with sand is greater, although the total (absolute) concentration of the solution may be slightly reduced by adsorption.

The effect of the introduction of ammonium sulfate into Shive's nutrient solution, or of the substitution of this salt for potassium nitrate in Tottingham's nutrient solution, on the growth of soybeans, was studied by means of the following criteria: (1) the general appearance of plants, (2) dry weight of tops, (3) dry weight of roots, (4) transpiration, (5) water requirement of tops, and (6) water requirement of roots.

The plants of the ammonium sulfate series, in general, appeared more healthy, more bushy and slightly higher, than the plants in the corresponding cultures of the Tottingham series. The most pronounced difference was in the color of the plants of the two series, the plants of the ammonium sulfate series being much greener than those of the Tottingham series.

The best yield of tops of soybeans in the ammonium sulfate series was in the culture containing 0.0156m. KH_2PO_4, 0.0036m. $(NH_4)_2SO_4$, 0.0108m. $Ca(NO_3)_2$, and 0.0174m. $MgSO_4$. The best cultures for the growth of tops in the Tottingham series had the four salts present in the following volume-molecular proportion: 0.0156m, KH_2PO_4; 0.0049m, KNO_3; 0.0036m, $Ca(NO_3)_2$; and 0.0029m, $MgSO_4$ for the one, and 0.0156m, KH_2PO_4; 0.0049m, KNO_3; 0.018m, $Ca(NO_3)_2$; and 0.0174m, $MgSO_4$ for the other. The poorest culture in both series was one in which seven-tenths of the total osmotic concentration was supplied by either KNO_3 (Tottingham series), or $(NH_4)_2SO_4$ (ammonium series). The best culture of the ammonium sulfate series, however, was considerably better than the best culture of the Tottingham series, while of the poorest cultures of the two series the culture of the Tottingham solution was better. The variation between the best and the poorest cultures in the ammonium sulfate series was much greater than in the Tottingham series. The plant growth of the cultures containing ammonium sulfate, on the whole, was much better than that of the cultures without this salt. There is pronounced tendency for the cultures of the ammonium sulfate series to show considerable fluctuations upon a slight alteration of the salt proportions. The fluctuations in this respect are not so striking in the Tottingham series.

The washed roots were burned in a platinum dish. The difference between the weight of the dish with material before and after the burning was taken as the weight of the roots. The dry weights of roots show, in general, the same main features of the difference between the two series as were pointed out in the case of tops. The culture producing the best root growth in the Tottingham series was the second of the two best mentioned cultures for the top growth in the same series. The best and the poorest cultures of the ammonium sulfate series were the same cultures that gave the best and the poorest yields of tops, respectively. The poorest culture of the Tottingham series for root development was one containing 0.0052m, KH_2PO_4; 0.0244m, KNO_3; 0.0108m, $Ca(NO_3)_2$; and 0.0058m, $MgSO_4$. The ammonium sulfate series had 11 cultures whose relative values were above 1.10, 1.00 being taken for the average of the two series, while only 5 cultures of the Tottingham series were above that value. The average root development in different salt proportions of the ammonium sulfate series was quite large as compared with that of the Tottingham series. In this respect the data for tops and roots show a very close agreement, and this relation between the growth of tops and that of roots in the same series is noticed throughout. The cultures in both series act more or

There is a close relation between the yield of soybeans and the transpiration. If the curves were drawn for these values they would run fairly in parallel. This relation is, however, more pronounced in the case of the ammonium sulfate series than in that of the Tottingham series.

The water requirement of tops lies between 192 c. c. and 354 c. c. per gram of dry matter in the ammonium sulfate series, and between 327 c. c. and 387 c. c. per gram of dry matter in the Tottingham series. On the average, it required somewhat less water to grow a gram of dry matter of tops in the ammonium sulfate series than in the cultures with the Tottingham series.

The water requirement of dry roots is, of course, many times as high as it is for tops. The number of cubic centimeters of water required to produce one gram of dry roots lies between 1840 and 2950 in the ammonium sulfate series, and between 1580 and 2595 in the Tottingham series. The average values are 2088 and 2060 gm., respectively.

During the repetition of the experiment, the cultures of the nutrient solutions proposed by Knop, Crone and Shive, respectively, were set together with the ammonium sulfate series in growing soybeans in sand cultures. Under the conditions of the experiment none of the solutions of the above-mentioned authors gave as good results as the best solution of the ammonium sulfate series.

V. A COMPARATIVE STUDY OF SALT REQUIREMENTS IN SOLUTION CULTURES FOR THE GROWTH OF BUCKWHEAT TO THE FLOWERING STAGE AND TO MATURITY

WILLIAM H. MARTIN

In a recent paper (2) having an important bearing on problems pertaining to the growth of plants in nutrient solutions, Shive has shown that the three salts mono-potassium phosphate, calcium nitrate, and magnesium sulfate, in solutions of suitable concentration, together with traces of iron as ferric phosphate, present a medium very suitable for general culture work. Shive employed an optimal series of 36 solutions, each having approximately the same total concentration measured in terms of possible osmotic pressure. In this series the salts were so distributed as to include all possible sets of salt proportions, for increments of change equal to one-tenth of the total concentration, thus producing 36 different salt proportions for the concentration employed. In a similar series Tottingham (4) employed the three salts in Shive's solution plus potassium nitrate, making 84 different salt proportions for each concentration employed.

The best growth of wheat tops in Shive's optimum series, which has a total concentration of 1.75 atmospheres, was obtained in a solution having the three salts in the following volume molecular partial con-

centrations, KH_2PO_4, 0.0180m; $Ca(NO_3)_2$, 0.0052m; $MgSO_4$, 0.0150m. With Knop's (1) solution expressed as 100 this solution showed an increase in the production of tops of 27 per cent on a dry-weight basis. Compare with the same standard, Tottingham's solution showed an increase of 10 per cent.

In an earlier paper Shive (3) gives the salt proportions of his optional series best adapted to the growth of buckwheat. This solution contains the three salts in the following volume molecular partial concentrations; KH_2PO_4, 0.144m; $Ca(NO_3)_2$, 0.0052m; $MgSO_4$, 0.0200m. On a dry-weight basis there was an increase of 61 per cent for tops over Knop's standard 4-salt solution as compared with an increase of 21 per cent noted for Tottingham's solution, likewise compared with Knop's.

The question arises as to whether the salt proportions required to produce maximum yields of buckwheat tops grown to the flowering stage in solution cultures would remain the same for the later stages of plant growth in the case of buckwheat from flowering stage to maturity. An attempt was made by the present writer to determine this point. The purpose of this report is to state, in a preliminary way, the results secured. A more complete presentation and discussion of the results will follow at a future date. This work was performed in the laboratory of plant physiology of the New Jersey Agricultural Experiment Stations.

The methods employed in this work were similar to those employed by Shive in his work with wheat. The plants were germinated and mounted in the manner described by him. The 3-salt solution was used with a trace of iron, as ferric phosphate, added to each solution. In every case the solution had an approximate osmotic concentration of 1.75 atmospheres as measured by the depression of the freezing point. The solutions were renewed every six days. Each culture contained 515 c. c. of solution.

When the seedlings were from 4 to 5 cm. tall they were transferred to a solution shown by Shive to be best adapted physiologically to the growth of buckwheat plants during the first four weeks of their development. This solution contains the three salts, KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$ in the partial volume molecular concentrations of 0.144m; 0.0052m; and 0.0200m. All the seedlings were grown in this solution for a period of 24 days. During this time little difference was apparent in the size and vigor of the plants in the different cultures. At the end of this growth period the plants were transferred to the 36 different solutions of the 3-salt series. These included all the possible sets of salt proportions for increments of change equal to one-tenth of the total osmotic concentration. The cultures were now continued until the seeds were fairly well matured. The plants were then harvested.

The solution giving the best growth of tops was made up of the three salts in the following volume molecular partial concentrations KH_2PO_4, 0.0108m; $Ca(NO_3)_2$, 0.0130m; $MgSO_4$, 0.010m. The solution giving the poorest growth contained the three salts in the following volume molecular partial concentrations, KH_2PO_4, 0.0036m; $Ca(NO_3)_2$, 0.0026m; $MgSO_4$, 0.00400m. This may be expressed in another way to bring out

more clearly the wide difference existing between the salt proportions giving the best and those giving the poorest growth. The solution giving the best growth is characterized by having three-tenths of its total osmotic concentration derived from mono-potassium phosphate; five-tenths from calcium nitrate, and two-tenths from magnesium sulfate, while the culture giving poorest growth of tops has one-tenth of its total osmotic concentration due to mono-potassium phosphate; one-tenth due to calcium nitrate and eight-tenths due to magnesium sulfate. These differences were apparent in the growth of the plants soon after they were placed in the different solutions. No injury was observed, but the plants in the cultures best adapted physiologically responded at once to the favorable salt balance and made a more vigorous growtb than those in the poorer solutions.

The solution found by Shive to give the best production of tops during the first growth period had four-tenths of the total osmotic concentration due to mono-potassium phosphate, two-tenths due to calcium nitrate and four-tenths due to magnesium sulfate. A comparison of this solution with the one giving the best yield of tops for the later period of growth shows the two solutions to be markedly different with respect to their salt proportions. The most striking difference is shown by the osmotic ratio of magnesium sulfate to calcium nitrate. In Shive's best solution for the first growth period it is 4:2 while it is 2:5 in the best solution for the second growth period. The ratio of calcium nitrate to the potassium salt is also very different, being 2:4 in Shive's best solution and 5:3 in the best solution for the second growth period.

When the cultures making up the series were transferred to the different solutions, two cultures were transferred to Tottingham's and Knop's 4-salt solutions of the same total concentration as the 3-salt solutions. Compared with Knop's the 3-salt solution showed an improvement of 28 per cent on a dry-weight basis of tops, while Tottingham's solution showed an increase of only 5 per cent over the same standard.

The solution physiologically best for the production of tops did not give the highest seed production. This solution was made up of the three salts in the following volume molecular partial concentrations: KH_2PO_4, 0.0072m; $Ca(NO_3)_2$, 0.0104m; $MgSO_4$, 0.0200m. On a dry-weight basis there was an increase of 31 per cent over Knop's solution. The increase shown by Tottingham's solution over Knop's was 5 per cent.

Table 57 gives the volume molecular partial concentration of the solution found by Shive to be best adapted physiologically to support the growth of wheat and buckwheat during the first four weeks of their development (i. e., the first growth period) and also the volume molecular partial concentration of the solutions found by the present writer to be best adapted to the production of buckwheat tops during the later growth period from the flowering stage to maturity. The increase in yield of tops, expressed in per cent on the basis of dry weight, for Shive's and Tottingham's solutions over Knop's 4-salt solution also is given.

Table 57

Comparison of Growth of Wheat and Buckwheat in Different Nutrient Solutions

Experimenter and Plant	Volume-molecular partial Concentrations of the Solutions			Increase over Knop's	
	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$	Shive's Solution	Tottingham's Solution
Shive—Wheat	0.180	0.0052	0.0150	27	16
Shive—Buckwheat to flowering stage..........	0.144	0.0052	0.0200	61	21
Martin—Buckwheat flowering stage to maturity....	0.0130	0.0130	0.0100	28	3

From these studies it is evident that Shive's 3-salt solution, at a concentration of 1.75 atmospheres diffusion tension, is a favorable medium for the growth of wheat and buckwheat for the first 24 days of their development. The present work would indicate also, that this solution is eminently fitted for the production and maturing of seeds of buckwheat. During this second growth period the plants made vigorous growth and produced an abundance of seed. With seed production as well as the production of tops for the corresponding period, the 3-salt solution has proven to be superior to either Knop's or Tottingham's 4-salt solutions.

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VI. EXPERIMENTS TO DETERMINE WHETHER ONE FORM OF PHOSPHORUS IN A COMPLETE NUTRIENT PLANT SOLUTION IS MORE AVAILABLE FOR THE GROWTH OF BUCKWHEAT SEEDLING THAN ARE OTHER FORMS

ROSS L. BANCROFT

The regular Tottingham[1] nutrient solution was employed in these experiments and a study was made endeavoring to determine the relative availability of different forms of phosphorus in this solution. Experiments with five series of solutions were conducted, each series containing a different compound of phosphorus. The Tottingham nutrient solution, which includes the following salts, constituted the first series: KH_2PO_4, KNO_3, $Ca(NO_3)_2$, and $MgSO_4$. In place of the KH_2PO_4 of the Tottingham solution, the following phosphorus compounds were substituted in series 2, 3, 4, and 5, in the order given: NaH_2PO_4, $CaH_4(PO_4)_2$, $MgH_4(PO_4)_2$, and $(NH_4)H_2PO_4$.

Instead of using the entire 84 solutions as outlined by Tottingham, the representative number of 20 was selected and used in each series throughout the experiment. Buckwheat seedlings were grown to the flowering stage, which took about 23 days. The work was started in June and duplicated during August. At the time of harvesting, the tops and roots were separated and the oven-dry weights obtained on each. Besides the dry weights which indicated the relative plant growth, numerous notes were taken on the date any special injury to the plants was found. Also the height of each plant was determined at harvesting time. The nutrient solutions were renewed three times during the period of growth of the buckwheat. Every time the solutions were renewed, the amount of transpiration was measured and each solution was titrated against N/10 NaOH, in the hope of correlating plant growth indirectly with the amount of water transpired and the degree of acidity found in each solution.

The data obtained from the above experiments will not be tabulated here, and no interpretation of the data will be attempted in this report. Suffice it to say that great variations in the height, general growth, toxic effect, and final weights of the buckwheat plants were found. Large differences in the degree of acidity of the nutrient solutions were observed, and as the amount of acid increased, the tendency for the general health of the plants to be impaired became greater. The successful growth of buckwheat seems to depend not so much upon the availability of the phosphorus added as it does upon the total acidity of the solution in which the plant is growing. As a whole, the original Tottingham solution which contained the phosphorus in the form of

[1]Tottingham, W. E., 1914. A quantitative chemical and physiological study of nutrient solutions for plant culture. In Physiol. Research, V. 1, No 4, pp. 227-397.

KH_2PO_4, seemed to produce a larger total dry weight of plant substance than did any of the other forms of phosphorus. The series containing the $(NH_4)H_2PO_4$ produced the smallest total growth of plant.

This data will be written up and the results discussed in detail later.

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REPORT OF THE DEPARTMENT OF ENTOMOLOGY

Department of Entomology

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Report of the Department of Entomology

THOMAS J. HEADLEE, PH.D.

INTRODUCTION

The attention of the entomologist has this year been devoted to: (1) the dissemination of information about injurious insects through the medium of letters to persons who have written requesting help; (2) the dissemination of timely information on the nature of and the methods to be used in combating specific insects which were this year sufficiently abundant to do large harm; (3) the prosecution of investigations on lines later to be described; (4) the prosecution of the work of mosquito control.

The personnel of the staff has not changed except that an additional stenographer has been employed.

INSECT CORRESPONDENCE

Besides advice of a general sort information concerning at least 171 different species of mites and insects has been requested.

ARACHNIDA

Latin Name	Common Name	Locality	Date
Bryobia pratenses Garman	Clover mite	Elizabeth	Mar. 12.
" " "	" "	Earleigh Heights, Md.	Mar. 30.
Eriophyes pyri Pgst	Pear-leaf blister mite	Montclair	June 3.
" " "	" " " "	Paterson	June 25.
" quadripes Shimer	Maple mite	Nelsonville	June 27.
Tetranychus bimaculatus Harv.	Red spider	Mantua	Aug. 8.
" " "	" "	New Brunswick	Aug. 16.
" " "	" "	Keansburg	Sept. 12.
Trombidium muscarium	Harvest mite	Mt. Holly	Oct. 6.
Tyroglyphus lintneri Osb	Mushroom mite	Trenton	Dec. 6, '16.
" " "	" "	Somerville	Jan. 7.
	Bud mites	Hackensack	July 25.

INSECTA

Thysanura

Lepisma saccharina Linn	Silver fish	La Gloria, Cuba	Nov. 7, '16.

Thysanoptera

Thrips sp.	Thrips	Pensauken	July 16.

Homoptera

Aleyrodes packardi, Morr	Strawberry White fly	Montclair	Aug. 19.
" " "	" " "	Summit	Aug. 4.
" vaporariorum Westa.	Greenhouse " "	Princeton	Nov. 8, '16.
" " "	" " "	Clinton	Jan. 9.
" " "	" " "	Sea Bright	Sept. 12.
" " "	" " "	Morristown	Sept. 20.
" " "	" " "	Quinton	Sept. 20.
" " "	" " "	E. Rutherford	Sept. 28.
Aphis brassicæ Linn	Cabbage aphis	Washington	Oct. 30.
" gossypi Glover	Melon aphis	New Brunswick	Dec. 21, '16.
" pomi DeG	Green apple aphis	Hackensack	Apr. 4.
" " "	" " "	Lyndhurst	July 7.
" " "	" " "	Allendale	Aug. 24.
" pseudobrassicæ Davis	False cabbage aphis	Haddonfield	Nov. 11, '16.
" " "	" " "	Egg Harbor	Oct. 4.
" setariæ Thos	Rusty plum louse	E. Rutherford	Sept. 28.
" sorbi Kalt	Rosy apple aphis	Matawan	June 10.
" " "	" " "	S. Orange	June 26, '16.
Aphididæ	Plant lice	Haddon Hts	Nov. 26, '16.
"	" " eggs	Merchantville	Feb. 2.
"	" "	Dunellen	Mar. 8.
"	" "	Belle Mead	Mar. 21.
"	" "	Tenafly	Mar. 21.
"	" "	Earleigh Hts., Md.	Mar. 20.
"	" "	Riverton	Apr. 30.
"	" "	Maplewood	May 25.
"	" "	Caldwell	May 28.
"	" "	Bound Brook	June 6.
"	" "	Long Branch	June 7.
"	" "	Hackensack	June 7.
"	" "	Pocono, Pa.	June 14.
"	" "	Louisville, Ky.	June 22.
"	" "	Westfield	June 22.
"	" "	Allentown	June 25.
"	" "	Riverton	June 30.
"	" "	Bloomfield	July 6.
"	" "	Paterson	July 6.
"	" "	Plainfield	July 6.
"	" "	Port Richmond, N. Y.	July 6.
"	" "	Rahway	July 6.
"	" "	Plainfield	July 7.
"	" "	Ridgewood	July 7.
"	" "	Bound Brook	July 8.
"	" "	Bound Brook	July 8.
"	" "	Ramsey	July 9.
"	" "	Ridgewood	July 9.
"	" "	Riegelsville	July 9.
"	" "	W. Englewood	July 9.
"	" "	Madison	July 10.

HOMOPTERA—Continued

Latin Name	*Common Name*	*Locality*	*Date*
Aphididæ	Plant lice	New York City	July 10.
"	" "	Westfield	July 10.
"	" "	New York City	July 10.
"	" "	Paterson	July 10.
"	" "	Allendale	July 11.
"	" "	No. Hampton	July 11.
"	" "	Ramsey	July 11.
"	" "	*Rutherford*	July 11.
"	" "	Bergenfield	July 12.
"	" "	Bound Brook	July 12.
"	" "	Mahwah	July 12.
"	" "	Somerville	July 12.
"	" "	Westfield	July 12.
"	" "	Bloomsbury	July 13.
"	" "	*Lyndhurst*	July 13.
"	" "	North Bergen	July 13.
"	" "	Paterson	July 13.
"	" "	Wyckoff	July 13.
"	" "	Hohokus	July 14.
"	" "	Nutley	July 14.
"	" "	New Melford	July 14.
"	" "	Waldwick	July 14.
"	" "	Westwood	July 14.
"	" "	Paterson	July 16.
"	" "	Union	July 16.
"	" "	Hanover	July 17.
"	" "	Madison	July 17.
"	" "	Naughright	July 17.
"	" "	Newton	July 17.
"	" "	Paterson	July 17.
"	" "	Ridgewood	July 18.
"	" "	Blue Anchor	July 18.
"	" "	Caldwell	July 18.
"	" "	Elberon	July 18.
"	" "	Summit	July 18.
"	" "	Verona	July 19.
"	" "	Newark	July 19.
"	" "	Woodbridge	July 19.
"	" "	Newark	July 19.
"	" "	Morris Plains	July 19.
"	" "	Newark	July 19.
"	" "	Bound Brook	July 20.
"	" "	Caldwell	July 20.
"	" "	*Denville*	July 20.
"	" "	Elizabeth	July 20.
"	" "	Perth Amboy	July 20.
"	" "	Ridgefield Park	July 20.
"	" "	Andover	July 23.
"	" "	Elizabeth	July 23.
"	" "	Glen Ridge	July 23.
"	" "	Garwood	July 23.
"	" "	Irvington	July 23.
"	" "	*Rahway*	July 23.
"	" "	Elmer	July 24.
"	" "	New York City	July 24.
"	" "	Roselle Park	July 24.
"	" "	East Orange	July 25.
"	" "	Matawan	July 26.
"	" "	New Brunswick	July 26.
"	" "	New York City	July 26.
"	" "	Parlin	July 26.
"	" "	*New York City*	*July* 27.
"	" "	Finderne	July 28.
"	" "	Clayton	July 29.
"	" "	Jersey City	July 30.
"	" "	Arlington	July 31.
"	" "	Rahway	Aug. 3.
"	" "	Asbury Park	Aug. 4.
"	" "	Bernardsville	Aug. 4.
Aphrophora parallela Say	Frog hoppers	Princeton	June 28.
Aspidiotus *hederæ Vall.*	Oleander Scale	*LaCrosse, Wis.*	*May* 2.
" perniciosus Comst.	San Jose Scale	Metuchen	Oct. 19.
Aulacaspis *rosæ Bouche*	Rose *Scale*	Montclair	May 17.

HOMOPTERA—Continued

Latin Name	Common Name	Locality	Date
Ceresa bubalus Fab.	Buffalo tree hopper	Earleigh Hts., Md.	Mar. 30.
Chermaphis abieticolens Thos	Spruce gall louse	Bernardsville	Apr. 2.
" " "	" " "	Kingston	Dec. 3.
" " "	" " "	Caldwell	June 21.
" " "	" " "	Ridgewood	Aug. 6.
" pinicortis Fitch	Pine bark louse	Maplewood	Dec. 22.
" " "	" " "	Cologne	Apr. 26.
" " "	" " "	New York City	May 10.
" " "	" " "	Princeton	June 20.
" " "	" " "	Plainfield	July 30.
" " "	" " "	Elizabeth	Aug. 6.
" " "	" " "	Mt. Ephraim	Oct. 24.
Chionaspis euonymi Comst.	Euonymous Scale	Somerville	July 12.
" pinifoliæ Fitch	Pine-leaf Scale	Rutherford	Mar. 2.
Chrysomphalus aonidum Linn.	*Circular Scale*	Hackensack	May 3.
Coccidæ	Soft scale	Hackensack	May 3.
Coccus hesperidum Linn.	Soft Brown Scale	LaCrosse, Wis.	May 2.
Eulecanium nigrofasciatum Berg.	Terrapin Scale	Swedesboro	Jan. 6.
" " "	" "	Collingswood	Sept. 11.
" " "	" "	Moorestown	Sept. 25.
" *quercicitronis Fitch*	*Soft Scale*	*Morristown*	*June 18.*
" tulipiferæ Cook	Tulip soft scale	Haddon Hts.	Jan. 4.
" " "	" " "	No. Paterson	Feb. 27.
" " "	" " "	New Brunswick	Apr. 25.
" " "	" " "	Elizabeth	Aug. 15.
" " "	" " "	Ridgewood	Aug. 18.
" " "	" " "	Ridgewood	Sept. 7.
" " "	" " "	Hillsdale	Aug. 3.
" " "	" " "	Camden	Aug. 11.
" " "	" " "	White House	July 19.
" " "	" " "	Princeton	Oct. 6.
" " "	" " "	So. Orange	Sept. 29.
" " "	" " "	Moorestown	Oct. 25.
Jassidæ Sp.	Leaf hopper	Newark	June 28.
" "	" "	Dumont	Aug. 6.
Lachnus sp.		Elberon	Oct. 5.
Lepidosaphes ulmi Linn.	Oyster-shell scale	Orange	Jan. 2.
" " "	" " "	Plainfield	Mar. 20.
" " "	" " "	Ridgewood	Apr. 13.
" " "	" " "	Tuckerton	Apr. 19.
" " "	" " "	*Plainfield*	*July 14.*
" " "	" " "	Jersey City	Sept. 28.
Longistigma caryæ Harr.	Plant louse	Mt. Holly	Nov. 9.
Myzus ribis Linn.	Currant aphis	Montclair	May 27.
" " "	" "	W. Orange	June 13.
" " "	" "	Cresskill	June 24.
Nectarophora pisi Kalt.	Green pea aphis	New Brunswick	Dec. 21.
Phenacoccus acericola King	Maple false scale	Flemington	Sept. 6.
" " "	" " "	Pompton Plains	July 16.
Phyllocoptis phlœscoptis Nal.	Plum gall	Pensauken	Feb. 27.
Pseudococcus sp.	Mealy bug	Jersey City	Aug. 31.
Psylla buxi Linn.	Box psylla	Bernardsville	June 19.
" pyricola Forst.	Pear psylla	Morrestown	Oct. 6.
Pulvinaria acericola Walsh & Riley	Cottony maple scale	Stockton	May 8.
" " " "	" " "	New York City	June 28.
" " " "	" " "	Arlington	July 2.
" " " "	" " "	Sussex	July 14.
" innumerabilis " "	" " "	Manasquan	Aug. 7.
" " " "	" " "	Plainfield	June 7.
Saissetia hemisphærica Targ.	*Hemispherical scale*	*Elizabeth*	Jan. 19.
Schizoneura lanigera Hausm.	Woolly apple louse	Gladstone	June 9.
" " "	" " "	New York City	Nov. 23.
" " "	" " "	P. Amboy	Nov. 20.
" " "	" " "	Verona	July 23.
" " "	" " "	Irvington	July 17.
" " "	" " "	Hilton	Sept. 18.
Tibicen septendecim Linn.	17-year locust	New York City	Feb. 5.
" " "	" "	Wyomissing, Pa.	June 22.
Typhlocyba comes Say	Grape leaf hopper	Merchantville	Aug. 3.

HOMOPTERA—Continued

Latin Name	Common Name	Locality	Date
HEMIPTERA			
Anasa tristis DeG.	Squash bug	Stockton	July 16.
" " "	" "	Port Jervis	July 25.
" " "	" "	*Roselle Park*	Sept. 8.
Arilus cristatus Linn.	Wheel bug	Trenton	July 16.
Cimex lectularius Linn.	Bed bug	Great Meadows	July 20.
	" "	Oradell	Nov. 14, '16.
Heterocordylias malinus Reuter	Apple red bug	Dunollen	May 7.
Lygus pratensis Linn.	Tarnish plant bug	Moorestown	Feb. 20.
" " "	" " "	E. Rutherford	July 28.
Pentatomidæ sp.	*Stink bug*	*Dumont*	*Aug. 6.*
" "	" "	Short Hills	Aug. 27.
Orthoptera			
Acrididæ	Locusts	New Brunswick	Aug. 9.
"	Grasshoppers	Elizabeth	Aug. 4.
Blattidæ	Cockroaches	Plainfield	Aug. 14.
Gryllidæ	Cricket	Belmar	Sept. 17.
Microcentrum rhombifolium Sauss.	Katydid	Sewell	Feb. 8.
" " "	"	Belmar	Feb. 26.
" " "	"	Elizabeth	Aug. 30.
" " "	"	Riverton	Mar. 30.
" " "	"	Englewood	Nov. 27, '16.
" " "	"	Secaucus	Jan. 10.
" " "	"	Moorestown	Feb. 1.
Oecanthus nigricornis Walker.	Tree cricket	Ridgewood	Apr. 2.
Paratenodera sinensis Sauss.	Chinese Mantid	Riverton	Feb. 5.
" " "	" "	Haddonfield	Apr. 16.
Pterophylla perspicellata L.	Katydid	Roselle	Jan. 5.
" " "	"	Ridgewood	Apr. 2.
Stagmomantis carolina Johann	Mantid	Maple Shade	Feb. 2.
Coleoptera			
Alaus oculatus Linn.	Click beetle	Woodbury	June 5.
Amphicerus bicaudatus Say	*Apple twig borer*	*Linwood*	*May 29, '16.*
Anthonomus signatus Say	Strawberry weevil	Pleasantville	Dec. 18.
" " "	" "	Jersey City	Mar. 19.
" " "	" "	Wading River	Apr. 20.
" " "	" "	Hammonton	May 1.
" " "	" "	Atco	May 23.
Balaninus caryæ Horn	Hickory-nut weevil	New York City	Nov. 21, '16.
" " "	" " "	*Summit*	Dec. 11, '16.
Bruchus obtectus Say	Bean weevil	New York City	Feb. 1.
" " "	" "	Bound Brook	Mar. 29.
" " "	" "	Perth Amboy	Apr. 11.
" " "	" "	New York City	Apr. 18.
" " "	" "	Plainfield	May 27.
" " "	" "	Caldwell	May 28.
" " "	" "	*Paterson*	*June 2.*
" " "	" "	May's Landing	July 18.
" " "	" "	Bloomsbury	July 23.
" " "	" "	Newark	Aug. 10.
" " "	" "	Haddon Heights	Aug. 13.
" " "	" "	Summit	Aug. 16.
" " "	" "	Belle Meade	Aug. 22.
" " "	" "	*Lakewood*	Aug. 26.
" " "	" "	Gillette	Aug. 27.
" " "	" "	Franklinville	Sept. 25.
" " "	" "	Haddonfield	Sept. 18.
Bruchus sp.	Weevils	Moorestown	Feb. 8.
Buprestidæ	Borer	Pattenburg	July 17.
Byturus unicolor Say	American raspberry beetle	Sparta	May 29.
" " "	" " "	Sparta	June 25.
Calandra oryzæ Linn.	Rice weevil	Agassiz, B. C.	Nov. 11, '16.
Chrysomelidæ	Flea beetle	Flauerne	July 28.
"	" "	Lebanon	Feb. 1.
Coleoptera	Borer	Keyport	Aug. 3.
"	"	Rahway	Apr. 25.
Conotrachelus nenuphar Hbst.	Plum curculio	Toms River	Oct. 31, '16.
" " "	" "	Palmyra	Jan. 21.
" " "	" "	Lambertville	Feb. 4.
" " "	" "	Aura	Feb. 12.

COLEOPTERA—Continued

Latin Name	Common Name	Locality	Date
Conotrachelus nenuphar Hbst.	Plum curculio..........	Philadelphia, Pa.......	Mar. 20.
" " "	" "	Elizabeth	May 31.
" " "	" "	Long Branch..........	June 7.
" " "	" "	Flemington	June 17.
" " "	" "	S. Orange.............	June 26.
" " "	" "	Teaneck	July 7.
" " "	" "	Plainfield	Sept. 5.
" " "	" "	Metuchen	Oct. 19.
Cotalpa lanigera Linn........	Goldsmith beetle.......	Burlington	May 25.
Cryptorhynchus lapathi Linn.	Poplar borer...........	Kinkora	July 20.
Diabrotica 12-punctata Oliv..	Southern corn root worm	Bridgeton	Nov. 10, '1
" vittata Fab.	Striped cucumber beetle	Englewood	Apr. 30.
Elateridæ	Wire worms...........	New York City.........	Oct. 30, '1
"	" "	Englewood	Feb. 26.
"	" "	Great Meadows	June 4.
"	" "	New York City........	June 15.
"	" "	Newark	June 20.
Epitrix cucumeris Harris.....	Potato flea beetle......	Robbinsville	Mar. 16.
" " "	" " "	Hackettstown	May 20.
" " "	" " "	Flemington	May 23.
" " "	" " "	Trenton	June 17.
" " "	" " "	New Brunswick........	June 5.
" " "	" " "	Barnegat	June 6.
" " "	" " "	Chester	June 8.
" " "	" " "	Montclair	June 8.
" " "	" " "	Boonton	June 9.
" " "	" " "	Bound Brook..........	June 9.
" " "	" " "	Rahway	June 13.
" " "	" " "	Cream Ridge..........	June 20.
" " "	" " "	Pompton Plains.......	June 21.
" " "	" " "	Woodbury Heights.....	June 25.
" " "	" " "	Martinsville	June 25.
" " "	" " "	Garwood	July 23.
" " "	" " "	Trenton	July 29.
" " "	" " "	Princeton	July 30.
" " "	" " "	Westfield	Aug. 5.
Euphoria inda Linn..........	Brown fruit-chafer....	Newton	Sept. 8.
Fidia viticida Walsh.........	Grape root-worm.......	Morristown, Pa........	Aug. 10.
Ithycerus nova-boracensis Forst	Curculionid	Eatontown	June 25.
Lachnosterna fusca Froehl....	May beetle...........	Jersey City............	Jan. 24.
" sp.	" "	Atlantic City..........	Jan. 23.
" "	" "	Morristown	Mar. 30.
" "	" "	*Merchantville*	*May* 24.
" "	" "	Linden	June 15.
" "	" "	Trenton	June 25.
Leptinotarsa 10-lineata Say..	Potato beetle..........	New York City.........	Dec. 27, '1
" " " ..	" "	Barnegat	June 6.
" " " ..	" "	Freehold	July 5.
" " " ..	" "	Far Hills.............	July 24.
Macrodactylus subspinosus Fab.	Rose bug.............	Trenton	Apr. 9.
" " " .	" "	Little Silver..........	June 15.
" " " .	" "	Vineland	June 19.
" " " .	" "	Englewood	June 22.
" " " .	" "	Plainfield	June 25.
" " " .	" "	Teaneck Park..........	June 28.
" " " .	" "	West End.............	June 28.
" " " .	" "	West New York........	July 3.
" " " .	" "	Plainfield	July 3.
" " " .	" "	Hopewell	July 4.
" " " .	" "	Rutherford	July 6.
" " " .	" "	Hopewell	July 29.
Mononychus vulpeculus Fab..	Beetle	Rutherford	June 12.
Oberea bimaculata Oliv.......	Cane borer.............	Newton	May 26.
Phyllotreta armoraciæ Fowlr.	Flea beetle............	Paterson	June 2.
Platydema excavatum Smith..		Cape May Court House.	Oct. 22.
Saperda candida Fab.........	*Round-headed apple tree* borer	Hackettstown	Sept. 11.
Scolytus rugulosus Ratz.......	Fruit tree bark beetle..	W. Englewood.........	Jan. 14.
" " "	" " " " ..	Earleigh Heights, Md..	Apr. 16.
" " "	" " " " ..	Flemington	Sept. 11.
Silvanus surinamensis Linn...	Saw-toothed grain beetle	Hackettstown	Sept. 25.
Strigoderma arboricola Fab....	Beetle	*Woodbury*	*July* 5.

LEPIDOPTERA

Latin Name	Common Name	Locality	Date
Ampelophaga myron Cram...	Grapevine hog-caterpillar	Atlantic City	Jan. 24.
Archips sp.	Leaf roller	Tenafly	Mar. 20.
Bembecia marginata Harr.	Raspberry root-borer	Cape May	Dec. 18.
Callosamia promethea Dru.	Promethea moth	Freneau	Apr. 16.
" " "	" "	Allmuchy	Mar. 8.
Carpocapsa pomonella Linn.	Codling moth	Toms River	Oct. 31, '16.
" " "	" "	Geneva	Nov. 11, '16.
" " "	" "	New York City	Nov. 22, '16.
" " "	" "	Glen Ridge	Dec. 12, '16.
" " "	" "	Cream Ridge	Mar. 14.
" " "	" "	Pittstown	Apr. 25.
" " "	" "	Delaware	Apr. 25.
" " "	" "	Flemington	May 28.
" " "	" "	Camden	Sept. 11.
" " "	" "	Metuchen	Oct. 19.
Citheronia regalis Fab.	Hickory horned devil	Monmouth Junction	Aug. 26.
Datana integerrima G. & R.	Black walnut caterpillar	Freehold	May 31
" " "	" " "	Elizabeth	Aug. 13.
" ministra Dru.	Yellow necked caterpillar	Bernardsville	Aug. 6.
" " "	" " "	Plainfield	Aug. 30.
Diacrisia virginica Fab.	Moth	Flemington	May 28.
Diaphania nitidalis Cram.	Pickle worm	Atlanta, Ga.	May 12.
" " "	" "	Milwaukee, Wis.	Sept. 24.
Drasteria erechtea Cram.	Moth	Flemington	May 28.
Dryocampa rubicunda Fab.	Maple worm	Palmyra	July 22.
Enarmonia prunivora Walsh.	Lesser apple worm	Toms River	Oct. 31, '16.
" " "	" " "	Toms River	Nov. 1, '16.
Galleria melonella Linn.	Bee Moth	Springfield	Dec. 1, '16.
Halisidota sp.	Moth	New York City	July 23.
" "	"	Bernardsville	Aug. 13.
" tessellaris S. & A.	Pale tussock moth	Titusville	Sept. 12.
" " "	" " "	E. Rutherford	Sept. 28.
" " "	" " "	Newton	Oct. 6.
Harrisina americana Harr.	Grape leaf skeletonizer	Woodstown	Oct. 4.
Heliothis obsoleta Fab.	Corn ear worm	Toms River	Jan. 20.
" " "	" " "	New Brunswick	Jan. 2.
" " "	" " "	Jersey City	Apr. 30.
" " "	" " "	Asbury Park	June 27.
Hemerocampa leucostigma S & A.	White marked tussock moth	Mt. Holly	Feb. 27.
" " "	" " " "	Phillipsburg	July 17.
" " "	" " " "	Newark	July 23.
" " "	" " " "	Elizabeth	July 23.
" " "	" " " "	Chatham	Aug. 4.
" " "	" " " "	E. Rutherford	Sept. 19.
Hyphantria cunea Dru.	Fall web worm	Riegelsville	July 9.
" " "	" " "	Bernardsville	Aug. 12.
Lætilia coccidivora Comst.		N. Paterson	Feb. 27.
Laspeyresia molesta Busck.	Oriental peach moth	Springfield	Aug. 24.
" "	" " "	Brooklyn, N. Y.	Sept. 29.
Lepidoptera	Caterpillar	Newark	Oct. 28, '16.
"	"	Williamstown	Jan. 16.
"	Moth	New Brunswick	Mar. 18.
"	"	Bloomfield	May 10.
"	"	Merchantville	June 16.
"	Caterpillar	Williamstown	June 22.
"	"	Perth Amboy	July 24.
"	Moth	Trenton	June 26.
"	Caterpillar	Newark	July 27.
"	"	N. Montclair	Aug. 3.
"	"	Paterson	Aug. 11.
Leucania unipuncta Haw.	Army worm	Great Meadows	June 4.
Limacodidæ	Caterpillar	Cape May Court House	Aug. 11.
Malacosoma americana Fab.	Tent caterpillar	Gibbsboro	Jan. 24.
" " "	" "	Moorestown	Feb. 12.
" " "	" "	Pompton Plains	Feb. 21.
" " "	" "	Morristown	Mar. 22.
" " "	" "	Ridgewood	Apr. 2.
" " "	" "	Green Village	Apr. 12.
" " "	" "	Allendale	May 2.
" " "	" "	Elizabeth	July 27.

LEPIDOPTERA—Continued

Latin Name	Common Name	Locality	Date
Melittia satyriniformis Hbn.	Squash vine borer	Keyport	Nov. 19, '16.
" " "	" " "	Hackensack	May 13.
" " "	" " "	Glen Ridge	Apr. 21.
" " "	" " "	Elizabeth	Aug. 18.
Melalopha inclusa Hbn.	Poplar tent maker	Atlantic City	Jan. 23.
Noctuidæ sp.	Cut worm	New York City	Oct. 30, '16.
" "	" "	Riverton	June 4.
" "	" "	Bound Brook	June 6.
" "	" "	Washington	June 13.
" "	" "	Stelton	July 5.
" "	" "	Paterson	July 18.
" "	" "	Orange	July 20.
Oxyptilus periscelidactylus Fitch	Grape plum moth	Summit	June 1.
" " "	" " "	Caldwell	June 9.
" " "	" " "	Red Bank	June 11.
" " "	" " "	Hackensack	June 11.
" " "	" " "	Cranford	June 16.
Papaipema nitela Gn.	Stalk borer	New Brunswick	Aug. 7.
Peridroma saucia Hbn.	Variegated cut worm	Wortendyke	Feb. 19.
Phalonia rutilana Hbn.	Juniper web worm	Mt. Holly	June 1.
Phlegethontius sexta Johan.	Southern tobacco worm	Passaic	Aug. 13.
Phobetron pithecium S. & A.	Hag moth	Westfield	Aug. 24.
Pieris rapæ Linn.	Cabbage worm	Englishtown	May 2.
" " "	" "	Passaic	Aug. 13.
" " "	" "	New Brunswick	June 19.
" " "	" "	Passaic	Aug. 7.
" " "	" "	Rahway	July 17.
" " "	" "	Highland Park	Sept. 27.
Plodia interpunctella Hbn.	Indian meal moth	Hackettstown	Sept. 25.
Polychrosis viteana Clem.	Grape berry moth	Philadelphia, Pa.	Mar. 20.
" " "	" " "	Camden	Sept. 28.
Samia cecropia Linn.	Cecropia moth	E. Rutherford	Jan. 26.
Sanninoidea exitiosa Say	Peach tree borer	Burlington	Nov. 7, '16.
" " "	" " "	Bordentown	Nov. 8, '16.
" " "	" " "	Rutherford	Nov. 28, '16.
" " "	" " "	W. Englewood	Dec. 28, '16.
" " "	" " "	Gibbsboro	Jan. 13.
" " "	" " "	W. Englewood	Jan. 14.
" " "	" " "	Convent	Jan. 25.
" " "	" " "	Morristown	Mar. 20.
" " "	" " "	Plainfield	Apr. 4.
" " "	" " "	Englishtown	May 21.
" " "	" " "	Collingswood	May 22.
" " "	" " "	Westfield	May 22.
" " "	" " "	Hawthorne	May 28.
" " "	" " "	Washington	June 13.
" " "	" " "	Englewood	June 25.
" " "	" " "	S. Orange	June 28.
" " "	" " "	New York City	July 24.
" " "	" " "	Brooklyn	Aug. 10.
" " "	" " "	Camden	Sept. 11.
" " "	" " "	E. Rutherford	Sept. 19.
" " "	" " "	Camden	Sept. 26.
" " "	" " "	Elberon	Oct. 5.
Schizura concinna S. & A.	Red humped apple caterpillar	Sussex	Aug. 14.
Sesiidæ sp.	Clear winged moth	Merchantville	Aug. 12.
Sibine stimulea Clem.	Saddle back caterpillar	Trenton	Sept. 12.
" " "	" " "	Arlington	Sept. 19.
Sitotroga cerealella Oliv.	Angoumois grain moth	Moorestown	Feb. 3.
" " "	" " "	Beverly	Feb. 3.
" " "	" " "	Buena	Aug. 27.
" " "	" " "	Philadelphia, Pa.	Oct. 4.
Sphecodina abbottii Swains.	Sphinx moth	Stockton	July 24.
Sphingidæ	" caterpillar	Hackensack	July 28.
Thyridopteryx ephemeræformis Steph.	Bag worm	Gibbsboro	Jan. 24.
" " "	" "	Moorestown	Feb. 6.
" " "	" "	Freneau	Apr. 14.
" " "	" "	Salem	Apr. 24.
" " "	" "	Haddonfield	July 2.
" " "	" "	Mullica Hill	Aug. 7.
" " "	" "	Philadelphia, Pa.	Aug. 7.

LEPIDOPTERA—Continued

Latin Name	Common Name	Locality	Date
Thyridopteryx ephemeræformis Steph.	Bag worm	Bordentown	Aug. 17.
" " "	" "	Bordentown	Aug. 21.
" " "	" "	Atlantic Highlands	Aug. 22.
" " "	" "	Montclair Heights	Aug. 28.
" " "	" "	Vineland	Sept. 6.
" " "	" "	Paterson	Sept. 11.
" " "	" "	Princeton	Sept. 18.
" " "	" "	Mt. Ephriam	Oct. 6.
Tortricidæ	Leaf roller	N. Paterson	Feb. 27.
Apis mellifera Linn.	Honey bee	Hasbrouck Heights	Dec. 11, '18.
" " "	" "	E. Orange	Dec. 15, '18.
" " "	" "	Caldwell	Jan. 2.
" " "	" "	New York City	May 1.
" " "	" "	Salem	May 10.
" " "	" "	Brooklyn	May 14.
" " "	" "	Washington	May 14.
" " "	" "	Vineland	May 15.
" " "	" "	Demarest	May 22.
" " "	" "	Singac	May 22.
" " "	" "	Columbus	May 28.
Apis sp.	Bees	Campgaw	June 26.
" "	"	Mahwah	June 26.
" "	"	Rockaway	June 30.
Caliroa cerasi L.	Poplar slug	Andover	July 28.
Camponotus herculeanus pennsylvanicus DeG.	Carpenter ant	Plainfield	Apr. 12.
Camponotus herculeanus pennsylvanicus DeG.	" "	Metuchen	Oct. 19.
Diastrophus cuscutæformis Harr	Cane gall	Maple Shade	May 9.
Formicidæ sp.	Ants	Atlantic City	Mar. 8.
" "	"	Merchantville	Apr. 23.
" "	"	Boonton	May 20.
" "	"	Asbury Park	June 1.
" "	"	Plainfield	June 2.
" "	"	Spring Lake	June 3.
" "	"	Newark	June 4.
" "	"	Califon	June 4.
" "	"	Orange	June 4.
" "	"	Camden	June 19.
" "	"	Philadelphia, Pa.	June 20.
" "	"	Long Branch	June 27.
" "	"	Long Branch	July 5.
" "	"	Plainfield	July 10.
Ichneumonidæ	Ichneumon fly	Camden	Aug. 2.
Isosoma orchidearum Westw.	Cattleya fly	Convent	Feb. 7.
" " "	" "	Fall River, Mass.	Jan. 11.
Monomorium pharaonis Linn.	Red ants	Old Bridge	Sept. 11.
" " "	" "	Sewell	Sept. 25.
Pteronus ribesii Scop.	Cicada killer	Broadway	Aug. 2.
Vespa crabro Linn.	European hornet	Princeton	Oct. 24.
" " "	" "	Monmouth Junction	Oct. 26.
Siphonaptera			
Ctenocephalus canis Curt.	Cat and dog flea	Bridgeton	June 26.
" " "	" " " "	Forked River	July 16.
" " "	" " " "	Belleville	Sept. 8.
Pulex irritans Linn.	Human flea	Bordentown	Apr. 24.
" " "	" "	Bridgeton	June 30.
" " "	" "	Woodbine	July 18.
Diptera			
Acidia suavis Loew	Maggot in Eng. walnut husks	Bridgeton	Jan. 6.
" " "	" " " " "	Hartford	Oct. 2.
" " "	" " " " "	Bridgeton	Oct. 10.
Agromyza sp.	Leaf miner		Nov. 14, '18.
Chironomidæ sp.	Midge		
Culicidæ sp.	Mosquito	Philadelphia, Pa.	
" "	"	Rye Beach, N. H.	Jan. 12.
" "	"	Boston, Mass.	Jan. 15.
" "	"	Newton, Mass.	Jan. 30.
" "	"	Vancouver, B. C.	Feb. 1.
" "	"	Arlington, Mass.	Feb. 27.
" "	"	Rio Grande	May 5.

DIPTERA—Continued

Latin Name	Common Name	Locality	Date
Culicidæ sp.	Mosquito	Livermore, Me.	Mar. 12.
" "	"	Dayton, O.	Mar. 20.
" "	"	Rahway	Apr. 9.
" "	"	Providence, R. I.	Apr. 13.
" "	"	Rahway	Apr. 19.
" "	"	Fort Yatia, N. D.	May 1.
" "	"	Lewes, Del.	May 19.
" "	"	Morsemere	May 21.
" "	"	Baltimore, Md.	May 26.
" "	"	Chatham	June 18.
" "	"	Browns Mills.	June 21.
" "	"	Chatham	June 25.
" "	"	New York City	June 30.
" "	"	Middletown	July 3.
" "	"	Jersey City	July 10.
" "	"	Ridgewood	July 13.
" "	"	Lawrence	July 14.
" "	"	Newark	Oct. 19.
Diarthronomyia hypogæa H. Lw.	Chrysanthemum midge.	Warren Point	Apr. 12.
" " "	" "	New Brunswick	Apr. 18.
" " "	" "	Philadelphia, Pa.	Apr. 19.
" " "	" "	New Brunswick	Apr. 19.
" " "	" "	Rutherford	May 1.
" " "	" "	Secane, Pa.	May 23.
Eristalis tenax L.	Drone fly	Cape May Court House	Oct. 22.
Lasioptera vitis O. S.	Potato gall on grape	Passaic	June 21.
" " "	" " " "	Mendham	June 24.
Mansonia perturbans	Irritating mosquito	Middletown	July 9.
Monarthropalpus buxi Lab.	Boxwood leaf miner	Rumson	Jan. 11.
Musca domestica Linn.	House fly	Elizabeth	May 22.
" " "	" "	Maplewood	May 25.
" " "	" "	Montclair	July 11.
Pegomyia vicina Lintn.	Spinnach leaf miner	Boonton	Aug. 3.
Phorbia brassicæ Bouche	Cabbage maggot	New Egypt	May 8.
" " "	" "	New Brunswick	June 19.
" " "	" "	Bay Head	July 2.
" " "	" "	Millville	July 28.
" " "	" "	Elizabeth	July 30.
" ceparum Meig.	Onion maggot	Harlingen	Jan. 30.
" " "	" "	Brielle	Apr. 26.
" " "	" "	Linwood	June 6.
" " "	" "	Old Bridge	June 11.
" fusciceps Zett.	Seed corn maggot	Bridgeton	Dec. 18, '16.
" " "	" " "	Lumberton	May 20.
" " "	" " "	Keyport	June 20.
" " "	" " "	Newton	June 29.
Phytomza aquilegiæ Hardy	Columbine leaf-miner	Salem	June 2.
" chrysanthemi Kowarz	Chrysanthemum leaf-miner	Atlantic City	July 23.
" " "	" " "	Asbury Park	Aug. 31.
Psychoda sp.	Moth fly	Trenton	Oct. 6.
Phagoletis pomonella Walsh	Apple maggot	Toms River	Oct. 31, '16.
" " "	" "	Sea Bright	Sept. 14.
Sciara multiseta Folt	Mushroom fly	Leonia	Oct. 6.
Tipulidæ sp.	Crane fly	Wyoming	June 18.

INSECTS OF THE YEAR

This year has been especially marked by a widespread outbreak of plant lice on fruit and vegetables, an unusual activity of the plum curculio, the potato flea beetle, cabbage worms, June bugs, and rose bug, and various species of tussock moths. In greenhouses the chrysanthemum midge and the rose *Typophorus* have claimed attention. Among foreign species which have gained a foothold the

recognizedly injurious Japanese beetle (*Popilia japonica*) and a bay tree infesting psyllid are noteworthy, especially the former. No year in the writer's experience has better illustrated the need for that sort of insect scouting which will give a thorough fore-knowledge of insect outbreaks as an essential step in adequately protecting crops from injury.

Orchard Plant Lice

Before the opening of spring the presence of large numbers of shining black eggs on the twigs and smaller branches of the apple orchards in many parts of the state clearly indicated that damage by orchard plant lice was likely to occur. The season opened late and remained cold. When the lice hatched from the eggs they thrived mightily and soon accomplished large damage.

Three species were concerned—the green apple aphis, the rosy apple aphis, and the oat aphis. Although the apple growers were warned of the danger many failed to get a control and suffered large damage. It is a pleasure, however, to say that all who sprayed properly obtained control of the insects and suffered no serious harm.

The oat aphis has already begun to return to the trees in large numbers and if the rosy comes back later, the outlook for trouble next year will be excellent.

Plum Curculio

The damage done this year by this insect was at once the most widespread and locally the most severe of the past five seasons. Orchards, the crops of which normally are not seriously troubled, have this year been badly damaged.

The attack seems to have come between the blossom-fall and the ten-days-after-blossom-fall spraying, at the time when the former had been practically eliminated by the washing of the rains and the growth of the fruit. Very little harm was done following the application of the latter spraying. In orchards standing near woodlands or plantings interspersed with old stumps or carpeted with grass, the damage was particularly severe.

Clean culture in the forepart of the season followed by a cover crop not producing a dense sod, the removal of stumps and the

cleaning out of overgrown fence rows will rob the beetles of their wintering quarters and reduce the number which must be fought. If followed by that type of spraying which will preserve the coating practically intact for the first month after the blossoms fall, damage by this insect, even under unfavorable conditions, will be greatly reduced if not rendered negligible. It seems reasonably certain that normally the regular and efficient spraying of the apple orchard will year by year cut down the amount of curculio injury to a point where it will be entirely negligible.

This season's experience most conclusively shows, however, that the application of merely the sprays listed in the spraying schedule may permit an unusual abundance of curculio to be followed by a failure to obtain satisfactory protection.

Potato Flea Beetle

This and other species of flea bettles have this season been extremely abundant. Appreciation of the damage which they do appears to be so slight among the growers that little effort has been made to control them.

Cabbage Worms

The caterpillars (principally of the imported cabbage worm) have been so unusually abundant this season that the cabbage crop has been considerably damaged. Here again failure to act against the worms has been followed by considerable harm.

June Bugs

This year has witnessed the largest number of these big, blundering, night-flying insects for several years. Tender foliage in the tops of poplar and oak trees has been badly eaten. Small trees and shrubs have in some places suffered severely. Rose bushes have been badly eaten. The work was done entirely at night and the grower usually did not discover the marauder.

The June bug is the parent of the white grub. Eggs have been laid in grass lands. If weather, or natural enemies do not greatly reduce the brood thus started, we may expect large damage next year and the year after to lawns, golf greens and crops planted on land this year in timothy, blue-grass and other grass sod.

Rose Bug

The rose bug appeared this year with more than its usual severity. The prevention of its work in apple orchards in 1915 and 1916 by the prompt application of self-boiled lime-sulfur has this year been extended to grape, peach and cherry with satisfactory results.

Vegetable Plant Lice

Potatoes, tomatoes, eggplants, cabbages, cauliflower, beans, peppers and other vegetable crops were this year very seriously and in some cases mortally damaged by various species of plant lice[1].

In the latter part of June it became evident from the number of winged lice found on various vegetables that an outbreak was probable. By the tenth of July large damage had been done to potatoes throughout the northern half of the state. Later at certain points in South Jersey similar but less serious damage was done.

Wherever a mixture composed of 1 part of 40 per cent nicotine to 500 parts of water to which soap was added at the rate of 2 pounds to 50 gallons of soft water, or 3 to 4 pounds to the same quantity of hard water, was applied in such a fashion as to wet thoroughly all the lice, they were destroyed and the damage promptly checked.

Great difficulty in making satisfactory applications of this mixture was experienced in some instances, owing to the fact that potatoes had met in the row when this insect was discovered, thus rendering treatments with wheeled machinery impracticable, and owing to the great scarcity of adequate spraying machinery.

Tussock Moths

Three species of tussock moths have attacked the foliage of elm, maple and other shade trees during the past season. While they have not done much real damage because the buds were well formed before any considerable defoliation took place, they have excited a great deal of alarm.

The white marked species (*Hemerocampa leucastigma* S. & A.), while more abundant during the forepart of the season did little harm at that time. On the twenty-first of July the writer saw

[1]The principal species upon cabbage, potatoes, tomatoes and eggplant was the green peach aphis (*Myzus persicae* Sulz). The species upon beans were (*Myzus lycopersicae* and *Aphis pseudobrassicae* Davis).

the greatest abundance of both the cocoons and eggs masses on the maple trees in the city of Trenton. The partial second brood appeared in only small numbers.

The hickory tussock moth (*Halisidota caryae* Harr.) and the pale tussock caterpillar (*Halisidota tessellaris* S. & A.), appeared in large numbers during the last days of August and continued feeding until the first of October.

Chrysanthemum Midge

During the last of March a prominent florist of Irvington called our attention to the work of this insect (*Diarthronomyia hypogæ* H. Lw.) upon chrysanthemums. The examination, which was promptly made, indicated that the infestation had just become established. This fact when taken with the well-known ability of the species to do large damage led us to advise the prompt destruction of all injured plants.

During the investigations of this problem it became clear that the insect was more widely distributed than had been thought. A letter of inquiry which was sent out for the purpose gave the following distribution:—Madison, Morris County; Rutherford and Warren Point, Bergen County; North Bergen, Hudson County, and New Brunswick, Middlesex County, in New Jersey, and Philadelphia in Pennsylvania.

The Rose Typophorus

This small brown leaf beetle (*Typophorus excavatum* Linn.) has appeared in the role of an insect seriously injurious to rose culture. The adult attacks the foliage of roses grown under glass and riddles it, paying especial attention to the tenderer leaves. Its work always delays and sometimes well-nigh ruins the plants. It is especially fond of certain varieties such as Lady Russell, but seems to use all the common kinds.

Only one greenhouse concern is affected, so far as we now know, and only two houses at this point show its presence. The trouble first appeared in August. Following fumigation with hpdrocyanic acid gas it almost disappeared, but during October it again became troublesome.

Recently Introduced Foreign Insects

Perhaps the most important of this year's developments is the finding of a serious infestation of the Japanese Popilia (*Popilia*

japonica) in Burlington County. This insect, which reminds one in its feeding habits of the rose-bug, has a long list of food plants including grape, cherry, roses, Virginia creeper, elder, crataegus, althea, smartweed, tear thumb, evening primrose, ragweed, velvet leaf and jewel weed. It seems to have a peference for smartweed, grape, cherry, and rose. In Japan it is recorded as an enemy of string beans, grapes, peas, and peanuts. The damage is done primarily by the adult beetle.

The beetles begin emerging in the latter part of June and remain on the wing into September. Eggs are laid in the soil above which the beetles are feeding. The grubs hatch and live in the soil throughout the rest of the summer, the following winter, and as much of the following summer as is necessary to reach maturity.

The present infestation covers an area in a scattering fashion of several square miles. The heavy infestation is confined to an area about a half-mile square.

It is expected that the State Department of Agriculture will next season undertake a campaign for the eradication of this species.

A European psyllid known as *Trioza alacris* was introduced into New Jersey on imported stock, apparently from Belgium, several years ago. It attacks the foliage of bay both under glass and in the open. Its activity causes the leaves to curl, discolor and blister. When a curled leaf is opened the small lice are found within covered by a white waxy secretion. The insect which belongs to the sucking group, inserts its beak through the rind and withdraws the sap until the trees have a sickly appearance.

Winter is passed in the bay trees as an adult and the species becomes active when the trees are removed from cold storage and placed outside. Eggs are laid on the under-sides of the leaves near the margin. There are two broods out-of-doors during the summer season.

Fumigation with hydrocyanic acid gas or tobacco during winter has been found to destroy the species.

The infestation of the European mole cricket (*Gryllotalpa gryllotalpa*) described in the Annual Report for 1915 is still present, but no spread has taken place nor have any new infestations been discovered. The owners of the land on which this infestation occurs are fighting the insect by hunting out and destroying the nests during June and July.

Insect Scouting

Perhaps the most important factor in furnishing *timely* information to growers on the methods of controlling insects is a thorough knowledge of the activities of all injurious species at all times of the year. It has been the writer's experience that nearly every species exhibits an undue number of healthy representatives for some time previous to the doing of sufficient damage to constitute an outbreak.

With foreknowledge it would be practicable to draw the growers' attention to impending danger in time to permit the taking of reasonably adequate measures of prevention. This foreknowledge of insect outbreaks can be had only through a system of scouting which covers all parts of the state with sufficient frequency to keep track of the status of all seriously injurious species.

CLIMATE AND INSECT INVESTIGATIONS

This investigation deals with the problem of measuring the effect of climate upon the life and seasonal cycles of injurious insects and their natural enemies. It is an attempt to attack the problem from the standpoint of measuring the effect of specific climatic factors such as temperature, moisture, light, etc.

During the present season our attention has been devoted to: (1) the effect of atmospheric moisture upon the activity of the angoumois grain moth or "fly weevil," one of the most serious of the insects attacking stored grains; and (2) further tests of the effect of atmospheric humidity on the activity of the bean weevil.

Just at present our attention is centered upon the problem of measuring the effect of atmospheric moisture upon the grain-infesting species.

These factors of climate in their extremes are powerful insecticides and a study of them is not only certain to teach us how to forecast the effect of weather conditions and thus to know when to strike a species that may soon develop into a serious pest, but will yield new specific methods of controlling many of the species worked with.

Atmospheric Humidity and the Angoumois Grain Moth

A set of experiments was arranged to determine the effect of atmospheric humidity upon the rate of metabolism of the angoumois grain moth. Five flasks were selected. In each a section of a yellow flint corn ear (cob and all) was placed. Ten moths were introduced into each flask.

One was set aside as a check. Each of the other four was placed in an incubator chamber held constantly at 80°F. and quite dark except for little flashes now and then from the thermostat and pilot lights and the short periods during which the doors were open to permit examinations. Each flask by means of its glass inlet and outlet tubes is connected with an air line, through which an air current of 80°F. and of a specified moisture content travels at the rate of about a liter in ten minutes. The insects are left under these conditions until the entire life cycle has been completed.

Table 1

Effect Upon Amount of Atmospheric Moisture on the Angoumois Grain Moth

Chamber number	Atmospheric moisture per cent	Date of maximum death	Date of maximum emergence	Length of life cycle in days	Number of individuals produced	Remarks
1	Less than 1	3/24, '17	0	0	0	
2	100	3/23, '17	4/25	33	1	Fungi active
3	73	3/24, '17	4/28	35	21	
4	24	3/24, '17	0	0	0	
Check		3/23, '17	nothing out 5/16, 1917			All alive

The rate of metabolism in the life cycle of the angoumois grain moth appears to increase with the moisture, being most rapid at 100 per cent (table 1). Owing to the fact that fungi attack and destroy the insect at such high moistures, the optimum moisture must be specified as the highest percentage which will not encourage the heavy growth of fungi.

It is also clear that this insect, like the bean weevil, is unable to withstand low atmospheric moisture.

A Further Test of the Effect of Atmospheric Moisture Upon the Bean Weevil

The fact that the machines were employed on a study of the angoumois grain moth was taken advantage of to run another experiment on the effect of atmospheric moisture upon the rate of metabolism in the bean weevil.

Table 2

Effect of Amount of Atmospheric Moisture on the Bean Weevil

Chamber number	Atmospheric moisture per cent	Date of maximum death	Date of maximum emergence	Length of life cycle in days	Number of individuals produced	Remarks
1	Less than 1	3/25, '17		0	0	
2	100	3/27, '17	4/23	27	158	A considerable amount of fungus
3	73	3/27, '17	4/25	29	209	
4	24*	3/26, '17	5/3	38	13	
Check		3/26, '17	not out 5/18, 1917			All alive

Thus again we see that the rate of metabolism in the bean weevil life cycle increases as the moisture, and that the optimum lies in the highest per cent of moisture that will not encourage heavy growth of fungi (table 2).

The question of the effect of atmospheric moisture upon the life cycle is important from the standpoint of the use of low atmospheric moistures as an insecticide. While the machines were running a set of experiments bearing upon this point were carried out.

Enough small white beans were placed in each of twelve flasks to cover the bottom evenly. Twenty-five bean weevils were placed in each flask. The charged flasks were divided into three lots—the first to be placed under the controlled conditions at once, the second to be placed only after the eggs had hatched and the larvæ penetrated the beans and the third to be introduced only after the pupal stage had begun.

*A break occurred in this line giving for a short period a higher per cent of humidity.

Table 3

Effect of Atmosphere Moisture on Different Stages of the Bean Weevil

Stage of insect when placed in incubator	Date when placed in incubator	Number Emerging in Chamber				Remarks
		No. 1 Less than 1 per cent moisture	No. 2 100 per cent	No. 3 73 per cent	No. 4 24 per cent*	
Egg	3/13, 1917	0	98	42	3	Some fungus on No. 2
Larva	3/20, 1917	0	17	13	6	Some fungus on No. 2
Pupa	4/17, 1917	1	1	17	10	Covered with fungi in No. 2

*A break in the air line running through chamber No. 4 and a consequent rise in the relative humidity will serve to explain the ability of the egg stage to survive the apparently prohibitively dry air.

The results as set forth in table 3 conclusively indicate that low atmospheric humidity most strongly affects the eggs, then the larvæ, and finally the pupæ.

Conclusions

The results set forth above when taken with those described in the 1916 report show clearly:

(1) That for at least two widely divergent species of the stored grain insect group—one a beetle and the other a moth—increase in atmospheric humidity *means increase in speed of metabolism* as measured by length of life cycle.

(2) That the optimum per cent of atmospheric humidity is the highest which will not encourage a heavy growth of fungi.

(3) That 100 per cent atmospheric humidity destroys by encouraging the growth of fungi and that low atmospheric moisture destroys directly—probably by the abstraction of water.

(4) That while the egg stage of the bean weevil, at least, is most sensitive to the effect of low atmospheric humidity, other stages are unfavorably affected.

(5) That low atmospheric moisture might be developed into an efficient insecticide for certain species of stored grain insects.

ORCHARD INSECT INVESTIGATIONS

Pear Psylla

The study of pear psylla control has been continued and increased in scope because of the contradictory results which the growers reported. Three orchards, each of which was a representative of its section of the state, were included. The orchard of Mr. W. H. Blackwell in the Delaware River Valley near Titusville, was taken to represent the northern portion of the state; the orchard of Mr. Lester Collins near Merchantville for the central rich loam region; and the orchard of Mr. W. H. Ellis near Vineland for the southern part. The two southern plantings consisted mainly of the Kieffer variety, while the northern one was composed principally of Bartlett.

Blackwell Orchard.—This orchard, consisting of about two acres of Bartlett trees, most of which are 25 feet high, has been very seriously troubled by psylla for several years. In the season of 1916, owing perhaps to application of the winter-strength lime-sulfur at too early a date, the psylla was not successfully controlled, and the fruit was considerably stained.

In 1917 it proved impracticable either to scrape the trees or to give them a winter treatment. When the flower buds were ready to open, the trees were thoroughly sprayed with commercial lime-sulfur (1 to 9).

In the course of an examination of the orchard on May 2, a very few psylla could be found on about one tree in ten. On this date the codling moth spray was being applied and "Black-leaf 40" at the rate of 1 to 500 was included. On July 30 a light infestation of pear psylla was found on the trees nearest the house. On October 25, all the trees, especially those near the house, had lost the foliage from the lower limbs and the psylla was very abundant.

Mr. Blackwell reports that the heavy infestation developed the last of August, almost coincidently with picking time, but that fruit was not blemished.

Ellis Orchard.—Although Mr. Ellis has three blocks of Kieffer pear the psylla has been troublesome only in the one nearest the house. There more or less damage has been experienced

annually for some years. In 1917 the entomologist looked over this orchard and recommended both winter and spring treatment. The application of the former proved impracticable. Winter-strength lime-sulfur was applied thoroughly just as the flower buds were ready to open. About two weeks later the trees were again sprayed thoroughly with a mixture of nicotine (3/4 pint of "Black-leaf 40"), soap (2 lbs.) and water (50 gal.)

On July 31 only a very light infestation could be found in the orchard nearest the house. On October 4 the orchard nearest the house showed a decided infestation on the leaves. The fruit showed only very slight staining. On November 1, adult psylla and nymphs about to mature were found on the trees, but all the young forms had disappeared.

Collins Orchard.—This planting, consisting of more than 100 acres, includes several varieties, the principal one of which is Kieffer. With a few exceptions the Kieffer is the crop producer and the other varieties are interplanted for the sake of cross fertilization.

In this orchard a large block was scraped, winter-treated, and spring-treated; and a small block was spring-treated only. At the outset, the winter treatment was applied very incompletely but later more care was exercised.

Before the blossoms opened psylla eggs were extremely abundant in all parts of the orchard but appeared in much greater numbers in those parts when the trees were large enough and dense enough to afford shade.

On July 26 pear psylla was found to be abundant in this orchard. The portions of the orchard which received no winter treatment were the most badly infested. The scraped and sprayed blocks were the clearest. The difference between the trees of the unscraped blocks that were treated with both scalecide and commercial lime-sulfur and those that were treated with commercial lime-sulfur alone was much greater than the difference between the twice-sprayed unscraped trees and the twice-sprayed scraped trees. This indicates, as might be expected, that the dormant spraying with scalecide was much more important than the scraping.

On October 5 an inspection of the entire orchard showed some infestation throughout. The scraped portion was only lightly infested.

At this time the fruit was reported to have been only slightly stained and much cleaner than last year.

Discussion of Results.—In all orchards the treatments reduced the infestation. In the Blackwell and Ellis orchard the fruit was practically unstained but the foliage was marked. In the Collins orchard the fruit was somewhat stained.

In the Blackwell and the Ellis orchards the psylla appears to have steadily increased in numbers from the last spraying until the close of the season. In the Collins orchard the psylla appears to have increased until late midsummer, then to have experienced a reduction.

In the Collins orchard there appeared a great number of new eggs and a considerable number of new nymphs within too short a period for them to have come from eggs which were laid previous to the treatments. Furthermore, some adults were found shortly after the spraying was completed. The small number of old nymphs found testifies to the egg destruction wrought by the spray, for previous to the treatment as many as two dozen eggs were found on a single fruit spur.

With these facts in hand it is obvious that scraping and winter spraying left a large number of adults, that the spring treatments failed to destroy all of the eggs, and that a considerable number of adults were still alive and actively laying eggs after the blossoms fell.

The facts gathered during this season's experience seem to show conclusively that while the number of psylla destroyed by the treatments at present recommended may sufficiently reduce the insect to prevent serious staining of the fruit, damage will in all probability be done to the foliage, and with a favorable season harm may be done to the fruit itself.

In view of the susceptibility of the adult to the action of 40 per cent nicotine, it may be that spraying just before the blossoms open with commercial lime-sulfur (1 to 9) to which nicotine has been added at the rate of ¾ pint to 50 gallons would destroy both the eggs and hang-over adults, and thus give a degree of reduction which would constitute control. What effect this mixture would have on the opening blossoms cannot be told without further study.

Peach Tree Borer

SOME EXPERIMENTS ON THE ADULTS AND EGGS AND OTHER NOTES

ALVAH PETERSON, PH.D.

During the summer of 1917 a study was made of the peach borer at the peach orchard of Mr. James M. Moon and Son near Clementon, N. J. This orchard has about eighty acres of seven to eight year old peach trees of different varieties which for several years has been heavily infested with borers. The larger part of the orchard is on a light white sand soil and the smaller portion on a heavier gravel sand soil.

The majority of experiments were conducted under two large screen cages located in the white sand portion of the orchard where the infestation was most severe. One all wire screen cage 12x12x9 feet was constructed about a peach tree while a second wire screen cage 8x8x6 feet with a wooden roof covered with tarred paper was placed in an open space beside the large cage. These cages were built and put into position by Mr. J. B. Moon and Mr. Robert Schellenger to whom we are greatly indebted for their cooperation and interest in this investigation.

The problem of the peach borer was approached from several aspects, but the principal lines of investigation were the feeding habits of the adult, the response of the female when ovipositing to various materials commonly used in spraying and other chemicals, the susceptibility of the eggs to certain contact insecticides and other compounds and the effectiveness of Scott tree protectors and various spray mixtures in keeping the larvæ out of the tree. The last-mentioned phase of the investigation cannot be reported on at this time, for it will be necessary to wait until the spring boring (1918) has been completed in order to obtain the desired data.

In respect to the food and feeding habits of the adult stage, it can be said that in all the experiments and observations made under cages or throughout the orchard and in nearby woods, no adult was ever seen to partake of or show any desire for food or liquid during its entire adult existence. Furthermore, it was repeatedly noted that males and females would emerge from pupæ in captivity and copulate, and then the female would proceed to deposit at least two-thirds the total number of eggs within her body. In one case 511 eggs were deposited, and during this period the female showed no desire for food or liquid of any description. In brief, these observations show clearly the improbability of developing an attractive poison bait for the adult.

From an anatomical point of view the mouth-parts of the adult and their connection with the œsophagus seems to be normal and compares favorably with similar structures in adults of other species of the *Lepidoptera* which are known to feed. This anatomical condition is readily seen in dissections made under a binocular microscope.

The following chemicals, along with decayed peaches and fresh peach gum, were used in a number of experiments to tempt the adults to

feed; corn syrup ("Karo", diluted one-half), cane sugar, honey, maltose, lactose, fructose, dextrine, acetic acid (25 per cent solution), ammonium hydroxide (weak solution), pyridine, alcohol (70 per cent solution), formic acid, clove oil and distilled water. All these materials were used in liquid form (when in dry state 1 gm. was dissolved in 10 cc. of water). Small Syracuse watch glasses were placed about the orchard near peach trees on inverted tin cans and filled with the various solutions. A careful watch was kept of these throughout a number of days, from 10 a. m. to 4 p. m. when the adults were abundant. The same materials were used under the 8x8x6 foot wire cage with numerous adults freely flying about in the cage. The various materials were also placed separately under small round cages, 6x9 inches, with one of more adults in each case. In all these experiments no adult peach borer ever visited any of the above liquids or showed any desire for them. In the course of the experiments, particularly those about the orchard, a number of insects visited the various solutions. Ants, flies and honeybees came to the honey and some of the sugars while male ants were also attracted by the formic acid solution.

For the purpose of obtaining adults for study some 250 to 300 pupæ were collected during the latter part of July and the first two weeks in August. These were buried one-half inch below the surface of moist sand held in discarded tin cans. There were 8 to 12 pupæ in each tin and the tin cans themselves were embedded to their full depth in the soil under the large covered cage. A small round wire cage, 6 inches in diameter, 9 inches high and opened at the bottom, was placed over each tin; consequently, the adults on emerging were in captivity. In only one or two cases did more than one adult emerge on the same day from pupæ in the same tin throughout the entire season. No definite records were kept on the exact length of the pupal stage, but, as a rule it took from three to four weeks to obtain adults from freshly constructed pupal cases. Some adults were also secured from underneath mosquito netting which was placed in the form of a cone about the base of 100 trees that were heavily infested with larvæ. This method of securing adults required considerable work and a daily inspection of the trees, and on the whole was not as satisfactory as the foregoing method.

During the past season the adults did not emerge in great abundance until the middle of August. A few were seen throughout the month of July, but they did not begin to appear in numbers until the last week in July, reaching their maximum emergence about the 15th of August and continuing to emerge until September 15, so far as known. All adults emerged during the early hours of the morning and, so far as observed, never came out after 9 a. m. Copulation between the male and female in all cases occurred between 9 a. m. and 1 p. m., but usually between 11 a. m. and 12:30 p. m. The time interval between emergence and the appearance of a desire for copulation varied considerably in different individuals and in the sexes. In one instance, less than an hour elapsed before one female was copulating with a captive male, while in

other cases 24 hours might elapse before the female showed any desire for copulation. From all observations it seems that females are ready to copulate sooner than males after emerging, at least it was noted that it was generally more difficult to induce males to copulate with females when both had emerged on the same day than if one introduced an older male or one caught at large.

Some investigators have been unable to get males and females to copulate in captivity, but my experience has been quite contrary to this. Whenever a female emerged she was transfered to a small round wire screen cage, 6 inches in diameter, 9 inches high and open at the bottom, which stood on an inverted peach carrier with a clean manila paper beneath the cage. Sometime between 9 a. m. and 12:30 p. m. the female would cling to the side of the cage, elevate and project the tip end of her abdomen and generally within a few minutes, usually not over five, one or more males from the orchard would be hovering about the cage. In one case some fifty males were captured about one caged female in less than one hour. The males always approached a female ready for copulation against the wind, which shows that the female emits some attractive odor. Also, in most instances the males would remain on the side of the cage opposite to that from which the wind was coming, even though the female might be on the other side. If one or more of the wild males were captured in a net and transferred to the cage in a large wide-mouthed bottle, copulation usually took place immediately. In a number of experiments reared males were used with as much success as to 90 minutes, varying with different individuals.

A male in copulating hovers over the female and strikes at the elevated caudal end of her abdomen with the caudal end of his abdomen. Often the male may strike several times before he succeeds in clasping. When successful he reverses his position and has his head in the opposite direction to that of the female. Usually he continues to fly for a few seconds after clasping but he soon settles down and copulates for 45 to 90 minutes, varying with different individuals.

Copulation in this species resembles closely copulation as it occurs in the lesser peach borer, as described by Mr. King. A more detailed account might be given concerning this act, but this has been carefully discussed by other workers. One point, however, should be mentioned concerning the behavior of the male. Apparently the male is very much excited when copulating, for he may strike at another male or even copulate with a dead female. In one experiment an unfertilized female had been accidentally killed some 18 hours previous to the experiment and she was on the bottom of the cage on her dorsal aspect with the caudal portions of her abdomen projecting. Two recently emerged inactive males and one active unfertilized female ready for copulation were also present in the same small cage. Several males were hovering about the outside of the cage and it was noted that one of these struck repeatedly at a male within which was clinging to the side of the cage opposite to that from which the wind was blowing (the female was on the opposite side). The wild male without the cage was caught in a net and

PLATE 1: Peach Borer.

ABBREVIATIONS: a—abdominal segment; b—normal depression on egg; c—exit or opening made by larva in hatching; e. s.—egg shell; h—head; r—resticulations or wax-like elevations on the egg; x—fragments of egg shell broken off by larva in hatching; y—hexagonal and variously shaped areas on egg; Ch—check branch; F—fish-oil soap 1 gm. to 32 cc.; LS—lime-sulfur, 1-9; Sc—Scalecide, 1-15; Sk—"fly-skat", 1-10; T. C.—tin cans containing pupæ in center between cut branches.

1. Normal egg of peach borer, view of broad side.
2. Normal egg of peach borer, view of narrow side.
3. Collapsed or shrivelled egg of peach borer, view of broad side.
4. Diagrammatic section through egg of peach borer, showing U-shaped position of larva before hatching.
5. Hatched egg of peach borer, view of narrow side showing exit and egg fragments.
6. Hatched egg of peach borer, view of broad side showing exit and eg fragments.
7. Diagram showing arrangement of peach branches (numerals) anc materials used (letters) in experiment started on August 21 a continued until September 31 (see discussion of certain chemicals and common sprays in female when ovipositing).

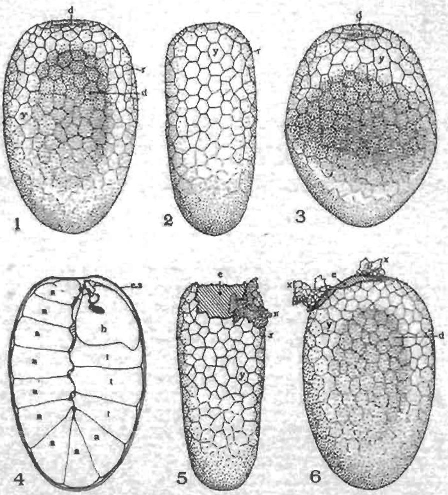
FIG. 1. Map of New Jersey showing drainage and mosquito conditions at the end of 1916.

FIG. 2. Map of the drainage established in Upper Township of Cape May County.

FIG. 3. Map of the drainage established in Egg Harbor Township of Ocean County.

FIG. D.—Statistics of Mosquito work in Essex County.

PLATE I



North

Ch/8   27/Sk   F/9   28/Ch   LS/10   29/Sc   Ch/11   30/Sc   LS/12   31/Ch   F/13   32/Sk   Ch/14

Sc/15 — 18/Sc

T.C.   T.C.   T.C.   T.C.   T.C.

West, LS/16 — 19/LS, East

T.C.   T.C.   T.C.   T.C.   T.C.

Sc/17 — 20/Sc

1/Ch   Sk/21   2/F   Ch/22   3/LS   F/23   4/Ch   F/24   5/LS   Ch/25   6/F   Sk/26   7/Ch

South

7

placed in the cage. After flying about for a few seconds, he was attracted by the dead female on the bottom of the cage and immediately struck at her abdomen and succeeded in clasping. He continued to copulate with the dead female for ten minutes. In the meantime, another male was introduced and copulation took place with the active female. It is noted in a number of cases, that an unfertilized female will continue to elevate and project the caudal end of her abdomen for two or three days and during this period males will continually visit the cage and try to copulate with the female within. During this period the unfertilized female may deposit some of her eggs but in no instance will she give forth the normal number. The largest number coming from an unfertilized female was 14, so far as known, and probably never over 50. Unfertilized eggs collapse (plate 1, fig. 3) on exposure to air after several days and never hatch.

After copulating the female starts to deposit eggs in 5 to 30 minutes. In depositing eggs she sways her abdomen from side to side and acts as though she were feeling about with the tip end for a suitable location for the eggs. When a desired spot is apparently found, which may be a crevice in the branch, under a piece of bark or even on the smooth surface of the branch, one to six eggs are usually deposited. She then flys about the cage for several seconds, at times two or three minutes, and will probably return to the same place where she deposited her first batch. Often the eggs are congregated in continuous areas of 50 to 100 eggs. The female will also deposit eggs on the wire screen of the cage, on the tin parts, on plain pine boards, on decayed peaches, peach leaves, fresh peach gum, on manila paper and other objects, but in the majority of the experiments the greater number of eggs were found on branches cut from peach trees.

Bright sunshine is not altogether necessary for copulation or egg deposition when adults are in captivity. No dark cloudy days occurred during the entire season, but on a few days the sun was obscured by clouds, most of the time, and under such conditions copulation took place as usual and some eggs were deposited, but not as many as on bright days.

During the bright days in August the female deposited eggs between 9 a. m. and 4:30 p. m. The majority of eggs were deposited on the afternoon of the day copulation took place, but the female usually continued to deposit eggs throughout the following day and in exceptional cases deposited some eggs on the third day; however, these were usually found on the floor of the cage, for the female on the third day was, as a rule, too weak to crawl up on the branch. In most experiments the female died on the third or fourth day, but before dying she became inactive and sluggish for 12 hours or more. Males and unfertilized females usually outlived the fertilized females by 24 hours, but so far as observed no adult lived over 5 days.

Table 4 gives the number of eggs deposited, the eggs retained within the abdomen and the total number of eggs possessed by 10 females used in various experiments.

Table 4
Eggs Deposited and in the Abdomen of Ten Females Used in Experiments

Female	Deposited	In abdomen	Total	Female	Deposited	In abdomen	Total
Expt. D.	452-74%	154-26%	606	Expt. M.	323-75%	104-25%	427
Expt. I	75-39%	117-61%	192	Expt. P.	305-66%	154-34%	459
Expt. J.	313-70%	132-30%	445	Expt. O.	218-34%	420-66%	638
Expt. K.	511-73%	187-27%	698	Expt. S.*	234-63%	133-37%	367
Expt. L.	372-69%	165-31%	537	Expt. V.*	342-69%	153-31%	495

*Female given only one day to deposit eggs.

The average number of eggs deposited by the ten females was 314.5 or 64.6 per cent of the average number of normal eggs, 484.4, possessed by an average female. The smallest number of eggs deposited by one female was 75 (Expt. I) and the greatest number 511 (Expt. K). The smallest female had a total of 192 eggs, while the largest possessed 698 eggs, or more than three times as many. In the above figures, the large white immature eggs found in the abdomen of all the females are not taken into consideration, but only the normal apparently mature chestnut brown eggs are included. As a rule, the large white eggs were not abundant, and so far as observed, were about 10 per cent of the total number of mature eggs. If the female will deposit two-thirds of all her mature eggs under cage conditions, it is likely that a greater proportion would be deposited under natural out-of-door conditions.

In watching the female deposit eggs it was noted that she seemed to use some care in choosing a favorable location. With this observation in mind, a few experiments were conducted to see what effect certain spray materials might have on the female when she was seeking a place to put her eggs. Various common sprays were tried such as "Scalecide," nicotine resinate, lime-sulfur, fish-oil soap and "Fly-skat," a commercial product which possesses a considerable amount of creosote (put up by Kil-Tone Chemical Company of Newark, N. J.). Crude carbolic acid also was tried in combination with "Scalecide" and fish-oil soap.

In each experiment one fertilized female was placed in a small round wire cage (6 inches in diameter and 9 inches high) along with two branches (1 inch in diameter and 8 inches long) cut from peach trees. These were placed in an upright position, one on the east side and one on the west, and every hour or so during the period when the female was depositing eggs the position of the branches was reversed in order that the light might not have any influence on the female. So far as known, light does not influence the female when depositing her eggs. One of the branches was sprayed and allowed to dry before using while the other served as a check. No branch was ever used in any experiment which had been cut and sprayed more than three days in advance of the experiment. Table 5 gives the time of spraying, which was always just after the branches were cut.

Table 5

Repellant Effect of Various Sprays on Female During Oviposition

No. of experiment	Spray used	Date branches were sprayed	Date deposited	Date observed	Eggs on check branch	Eggs on sprayed branch	Eggs on cage	Eggs on floor	Total eggs
A	"Scalecide," 1-15.	Aug. 4	Aug. 7-8	Aug. 8	129	16	3	37	185
				Aug. 9	129	16	3	45	192
B	"Scalecide," 1-20. Carbolic acid, 1-99.	Aug. 4	Aug. 7-8	Aug. 8	137	8	0	11	156
				Aug. 9	211	42	44	24	321
C	*Nicotine* resinate, 1-100.	Aug. 7	Aug. 8-10	Aug. 9	46	48	20	0	114
				Aug. 11	93	66	20	0	179
D	Lime-sulfur, 1-9.	Aug. 7	Aug. 8-10	Aug. 9	96	60	186	7	349
				Aug. 11	163	86	196	7	452
E*	Fish-oil soap, 1 gm.-100 cc. Carbolic acid, 1-99.	Aug. 7	Aug. 8-10	Aug. 9	16	14	0	0	30
				Aug. 11	20	18	0	11	49
F*	"Fly-skat," 1-10	Aug. 7	Aug. 9-12	Aug. 11	7	8	0	0	15
				Aug. 13	7	13	3	29	52
G**	*No spray.*		Aug. 11-12	Aug. 13	14	0	0	0	14
H	"Fly-skat," 1-10.	Aug. 11	Aug. 11-13	Aug. 13	64	56	72	25	217
				Aug. 14	64	75	72	28	239
I	Fish-oil soap, 1 gm.-100 cc. Carbolic acid, 1-99.	Aug. 11	Aug. 11-13	Aug. 13	24	31	17	3	75
				Aug. 14	24	31	17	3	75
J	"Scalecide," 1-15.	Aug. 14	Aug. 14-16	Aug. 16	37	53	141	82, (6)	313
				Aug. 17	37	53	141	82, (6)	313
K	Fish-oil soap 1 gm.-16 cc.	Aug. 14	Aug. 14-16	Aug. 16	313	27	92	8, (2)	440
				Aug. 17	313	27	118	53, (6)	511
L	Lime-sulfur, 1-9.	Aug. 14	Aug. 14-16	Aug. 16	80	6	130	75, (1)	351
				Aug. 17	80	6	130	96, (11)	372
M†	Fish-oil soap, 1 gm.-16 cc.	Aug. 14	Aug. 16-18	Aug. 17	104	15	48†	10	177
				Aug. 18	133	15	48†	127	323
N†	Lime-sulfur, 1-9.	Aug. 14	Aug. 16-19	Aug. 17	5	0	0†	0	5
				Aug. 18	25	8	0†	0	33
O†	"Fly-skat," 1-10	Aug. 17	Aug. 17-19	Aug. 18	160	25	174†	10	369
				Aug. 20	160	25	174†	133	492
P†	"Scalecide," 1-15.	Aug. 17	Aug. 17-19	Aug. 18	76	84	40†	35	355
				Aug. 20	76	84	40†	105	305
Q†	Fish-oil soap 1 gm.-32 cc.	Aug. 18	Aug. 18-20	Aug. 20	154	30	14†	8	206
				Aug. 21	154	30	14†	20	218
R†	"Fly-skat," 1-10	Aug. 20	Aug. 20	Aug. 21	212 *	16	41†	3	272
S†	Lime-sulfur, 1-9.	Aug. 20	Aug. 20	Aug. 21	103	53	72	6	234

*Fertility of female questioned. **Unfertilized female. ()Eggs on leaf.
†Cage sprayed with same material as sprayed on branch in experiment.

The results in the above experiments as recorded in table 6 are not as definite as might be wished for; however, they do bring out a few important points.

"Scalecide," 1-15, was used in experiments A, B, J and P, and in experiments A and B there was a decided repellent effect, while in experiment J and P the number of eggs on the sprayed branch was somewhat larger than the number on the check. This difference is not easily understood.

Nicotine resinate, 1-100, was used in one experiment and the results show that this material does not repel.

Lime-sulfur, 1-9, has some repellent effect, at least the number of eggs on the sprayed branches in experiments D, L, N and S was never more than 60 per cent (and usually less) of the number of eggs on the check, or unsprayed branch.

Fish-oil soap acted as a decided repellent in experiments K, M and O, while in Experiments E and I when combined with crude carbolic, 1-99, the repellent effect was counteracted. This combination seems to be less effective than soap alone, but the results are questioned, for the females in these two experiments (E and I) did not deposit the usual number of eggs, and the fertility of the female in experiment E is doubtful.

"Fly-skat," 1-9 and 1-10, a commercial product possessing a large quantity of creosote, showed a decided repellent effect in experiments O and R, while in experiment H it did not repel. Experiment F is questioned for the fertility of the female was not known.

On August 21, an experiment was set up in the large cage (8x8x6 feet) to determine the response of the female to various spray materials and was run continuously until September 21. Thirty-two peach branches, 1 to 2 inches in diameter and 18 inches long, were cut on August 21 and sprayed; 6 with "Scalecide," 1-15 (Sc), 4 with "Fly-skat," 1-10, (Sk), 6 with lime-sulfur, 1-9 (LS), 6 with fish-oil soap, 1 gm. to 32 cc. (F), and 10 checks (Ch), or unsprayed branches. These branches were placed under a wooden frame structure (36x18x18 inches) which was covered with white mosquito netting. The branches were arranged as in plate 1, figure 7. Branches 1 to 20 stood upright in the soil about 3 inches from the edge of the cage while branches 21 to 32 stood in the same line with 1 to 20, but were tilted (45° angle) toward the middle, and those opposite each other tied together at their top ends. Ten tin cans filled with moist sand soil and each possessing from 10 to 12 living pupæ in cases were buried in the soil in the middle between the rows of branches.

This experiment was carried on for 30 days, and during this period 60 adults emerged; at least 60 empty pupal skins were seen in all the tins on September 21, but what proportion of these adults were females is unknown. Some adults appeared as late as September 15, but none were seen after this date. Table 6 gives the number of eggs deposited on the various branches, sprayed and otherwise.

Table 6

Number of Eggs Deposited in Experiments on the Peach Tree Borer

Side and total eggs	No of branch	Spray	Eggs
South 1523	1	Check	685
	2	Fish-oil soap	108
	3	Lime-sulfur	72
	4	Check	176
	5	Lime-sulfur	96
	6	Whale-oil soap	126
	7	Check	261
North 2271	8	Check	525
	9	Fish-oil soap	203
	10	Lime-sulfur	234
	11	Check	342
	12	Lime-sulfur	182
	13	Fish-oil soap	245
	14	Check	540
West 766	15	"Scalecide"	256
	16	Lime-sulfur	175
	17	"Scalecide"	235
East 461	18	"Scalecide"	180
	19	Lime-sulfur	170
	20	"Scalecide"	111
South* 599	21	"Fly-skat"	22
	22	Check	164
	23	Fish-oil soap	83
	24	Fish-oil soap	176
	25	Check	118
	26	"Fly-skat"	36
North* 468	27	"Fly-skat"	76
	28	Check	101
	29	"Scalecide"	118
	30	"Scalecide"	51
	31	Check	91
	32	"Fly-skat"	31

*Branches inclined toward middle.

Table 7 gives the average number of eggs per branch, also the largest number on any one branch and the smallest number.

A study of the average number of eggs per branch in the above experiment shows that the average number of eggs on the check branches exceeds the average number of eggs on all the sprayed branches. The average number of eggs on branches sprayed with fish-oil soap (comparing similar averages) is 40 to 90 per cent that of the check. Branches sprayed with lime-sulfur show 50 per cent of the number found on the checks, while on the "Fly-skat" branches the eggs are reduced to 35 per cent that of the check. The number of eggs on "Scalecide" branches is between 46 to 86 per cent of the number found on the check branches. Since this experiment ran for 30 days one must take into consideration the possibility of considerable loss in the effectiveness of the various sprays on the different branches. How great this decrease was and its importance is unknown.

The above experiments, along with the individual experiments in table 6, show that the female in depositing eggs in captivity is undoubtedly influenced somewhat by various spray mixtures present on the branches of the tree, but in no case did any of the materials used completely repel the female and prevent her from depositing some eggs. In a number of cases the repellent served to cut down the number of eggs 50 per cent and in some instances the reduction was much greater than this. How the female would respond to these various mixtures when applied to the trees in the orchard and not under any sort of confinement is unknown, but so far as we know, she would probably hehave in a similar manner. There is a possibility that field observations could determine this point, but the results might be questioned for it is a difficult task to find the eggs on a large tree, and furthermore, one would never be certain that all had been seen.

Table 7

Peach Borer Eggs Found with Different Treatments

Branches	Average number of eggs per branch	Largest number of eggs per branch	Smallest number of eggs per branch
Check, upright, No. 1, 4, 7, 8, 11 and 14......	421	685	176
Check, slant, No. 22, 25, 28 and 31............	116	164	91
Check, average for all	300	685	91
Fish-oil soap, upright, No. 2, 6, 9, and 13.....	170	245	108
Fish-oil soap, slant, No. 23 and 24..........	129	176	83
Fish-oil soap, average for all................	156	245	83
Lime-sulfur, upright, No. 3, 5, 10, 12, 16 and 19	154	234	72
"Fly-skat," slant, No. 21, 26, 27 and 32.......	41	76	22
"Scalecide," upright, No. 15, 17, 18 and 20....	195	256	111
"Scalecide," slant, No. 29 and 30..............	84	118	51
"Scalecide," average for all..................	158	256	51

NOTE.—For branches No. 23 and 24, with an average of 129 eggs, adjacent check branches No. 22 and 25, with an average of 141 eggs, come closer to being true checks than the average number of eggs in all slants (116). Also for branches No. 29 and 30, with an average of 84 eggs, adjacent check branches No. 28 and 31, with an average of 96 eggs, come closer to being true checks than the average number of eggs in all slants (116).

It may be possible to find some sort of material which would repel the female and prevent her from depositing eggs wherever the material is found on the tree, but one point which must be considered in this phase of the peach-borer problem is the unknown probability that larvæ hatching from eggs well up on the branches in the tree may crawl or drop to the ground and eventually gain entrance to the tree. What is the fate of larvæ hatching from eggs deposited on the smaller branches and leaves of the tree? Personally, I have never seen a female deposit eggs on any other part of the tree than the main trunk, but a number of workers have recorded that eggs may be deposited almost anywhere on the tree and on weeds and grasses about the tree. If larvæ hatching from eggs on various parts of the tree eventually enter the tree near the crown of the plant, repellent sprays or washes would not be sufficient to prevent the female from depositing eggs unless the entire tree is treated.

Light seems to have little or no influence on the female when she chooses a place to deposit her eggs. A comparison of the number of eggs deposited on the branches on each side of the cage in the above large experiment shows but little difference. This also was true of the small cage experiments with various individuals, as shown in table 8, where two unsprayed branches were placed in an upright position on the east and west sides of the cage and allowed to remain in this position. The morning light was the strongest on the east branch and the afternoon light on the west branch.

Table 8

Borer Eggs Deposited in Different Parts of Cage

No. of Expt.	Date deposited	Date observed	Eggs on west branch	Eggs on east branch	Eggs on cage	Eggs on floor	Total eggs
T	Aug. 20	Aug. 21	70	51	79	25	225
U	Aug. 20	Aug. 21	76	113	195	6	390
V	Aug. 20	Aug. 21	133	20	183	6	342

Eggs

A few experiments were conducted with the eggs of the peach borer. A number of common sprays and other chemicals were used on the twigs, on which eggs were afterwards deposited, and also directly on the eggs before they hatched, and their effect noted.

The egg of the peach borer (plate 1, Fig. 1, 2) is a small flattened ellipsoidal body with one end broader (more obtuse) than the other and also slightly depressed (d). The egg averages 0.65 mm., or 1/40 of an inch in length, and 0.4 mm., or 1/60 of an inch at its greatest width. Two opposite surfaces of the egg are flattened (d), and in most cases slightly concave, one of these surfaces is adjacent to the object on which the egg is deposited. The egg has a soft chestnut brown color, and distinct hexagonal and variously shaped areas (y), marked off by somewhat elevated white lines (r) and these areas are more prominent toward the large end of the egg.

A distinct larva may be found within the eggs two or three days before hatching. It is in a U-shaped position with the head and caudal portions located near the large end of the egg (plate 1, fig. 4). When the larva is ready to emerge it breaks through the small thin depressed area (d) at the large end of the egg. It punctures the shell (e) with its mandibles and then continues to tear down the egg shell ventrad of its head until the opening is large enough for it to crawl out (plate 1, fig. 5, 6). In the tearing down process the bits and fragments (x) of the egg shell are not eaten by the larva, so far as observed, but pushed to one side, as shown in plate 1, figures 5 and 6. Since the egg shell is not consumed, as is the case with some insects, it is impractical to apply

scme sort of a stomach poison to the egg with the hope of killing the larva as it eats its way out of the shell. The eggs of the peach borer require 9 to 11 days to hatch, but in a few cases it took a day or two longer. An examination of a large number of eggs used in the various checks shows that in the majority of cases, 100 per cent of the eggs hatched which were deposited by fertilized females.

A few experiments were conducted to see what effct various spray mixtures would have on the hatching ability of peach borer eggs when the eggs were deposited on freshly sprayed branches (branches sprayed from 3 to 6 hours before eggs were deposited). Table 9 shows the results of these experiments.

Table 9

Effect of Various Sprays on Eggs When Applied Before Deposition

experiment	Spray	Date of application	Date eggs were deposited	Date of hatching	Total eggs	Eggs hatched	Eggs dead
1	Fish-oil soap, 1 gm.-100 cc. Crude carbolic, 1-99.	Aug. 11	Aug. 11-13	Aug. 23?	31	31	0
1	Check.		Aug. 11-13	Aug. 23?	24	24	0
2	"Scalecide," 1-15.	Aug. 14	Aug. 14-16	Aug. 24?	53	51	2
2	Check.		Aug. 14-16	Aug. 24?	37	37	0
3	Fish-oil soap, 1 gm.-16 cc.	Aug. 14	Aug. 14-16	Aug. 25-26	27	27	0
4	Lime-sulfur, 1-9.	Aug. 14	Aug 14-16	Aug. 25	6	6	0
5	"Scalecide," 1-15.	Aug. 17	Aug. 17-19	Aug. 28	28	26	2
5	Check.		Aug. 17-19	Aug. 28	42	42	0
6	"Fly-skat," 1-10.	Aug. 20	Aug. 20	Aug. 31-Sept. 4	17	12	5
7	Lime-sulfur, 1-9.	Aug. 20	Aug. 20	Aug. 31-Sept. 4	24	24	0
8	"Fly-skat," 1-10.	Aug. 17	Aug. 17-19	Aug. 27-28	25	25	0

In no experiment where the spray material was applied before the eggs were deposited did the spray materially affect the hatching of the eggs. Except for experiments 2, 5 and 6 all eggs on the sprayed branches hatched, and the few that failed to hatch may be explained on

other grounds. When experiment 6 is compared with experiment 8 one readily sees the probability of some other factor entering into experiment 6 than that of the spray alone.

The results of the experiments where the insecticide was sprayed on the eggs sometime within 1 to 5 days after deposition are shown in table 10.

Table 10

Effect of Various Sprays on Eggs

experiments	Spray	Date of application	Date eggs were deposited	Date of hatching	Total eggs	Eggs hatched	Eggs dead
1	"Scalecide," 1.15.	Aug. 6	Aug. 4	Aug. ?	47, (3)	0	44
2	"Scalecide," 1-15. Crude carbolic. 1-99.	Aug. 6	Aug. 4	Aug. ?	41	0	41
3	Nicotine resinate, 1-100.	Aug. 6	Aug. 4	Aug. ?	41	40	1
4	Lime-sulfur,	Aug. 6	Aug. 4	Aug. ?	41, (5)	23	13
5	Check.		Aug. 4	Aug. ?	50, (21)	27	2
6	"Fly-skat," 1-10.	Aug. 20	Aug. 18	Aug. 27	45	15	30
6	Check.		Aug. 18	Aug. 27	44	44	0
7	Fish-oil soap, 1-10.	Aug. 20	Aug. 19	Aug. 27	57	2	55
7	Check.		Aug. 18	Aug. 27	34	34	0
8	Fish-oil soap, 1-10. Crude carbolic, 2-98.	Aug. 20	Aug. 18	Aug. 27	61	0	61
8	Check.		Aug. 18	Aug. 27	33	33	0
9	"Scalecide," 1-20. Crude carbolic. 1-[illegible]	Aug. 13	Aug. 8	Aug. 17	40	7	33
9	Che[illegible]		Aug. 8	Aug. 17	93	93	0
10	Lime-[illegible] 1-[illegible]	Aug. 13	Aug. 8	Aug. 18-19	42	32	10
10	Che[illegible]		Aug. 8	Aug. 18-19	53	44	9
11	"Fly-s[illegible]" 1-1[illegible]	Aug. 17	Aug. 14-15	Aug. 25-27	47	45	2
12	Nicotine [illegible] 1-1[illegible]	Aug. 21	Aug. 16-18	Aug. 27-28	64	61	3
12	Che[illegible]		Aug. 16-18	Aug. 27-28	28	24	4

Table 10—(Continued)
Effect of Various Sprays on Eggs

No. of experiments	Spray	Date of application	Date eggs were deposited	Date of hatching	Total eggs	Eggs hatched	Eggs dead
13	"Scalecide," 1-30.	Aug. 21	Aug. 17-19	Aug. 27-29	103	43	60
13	Check.		Aug. 17-19	Aug. 27-29	11	11	0
14	"Scalecide," 1-20.	Aug. 21	Aug. 18-20	Aug. 30–Sept. 1	102	28	74
14	Check.		Aug. 18-20	Aug. 30–Sept. 1.	15	13	2
15	"Scalecide," 1-10.	Aug. 21	Aug. 20	Aug. 31–Sept. 1	104	24	80
15	Check.		Aug. 20	Aug. 31–Sept. 4	29	27	2
16	Laundry soap, 1-200.	Aug. 21	Aug. 20	Aug. 31–Sept. 4	60	54	6
17	Nicotine resinate, 1-100.	Aug. 21	Aug. 20	Aug. 31–Sept. 4	30	29	1
17	Check.		Aug. 20	Aug. 31–Sept. 4	31	28	3
18	Nicotine resinate, 1-250.	Aug. 21	Aug. 20	Aug. 31–Sept 4	102	100	2
18	Check		Aug. 20	Aug. 31–Sept. 4	11	11	0
19	Nicotine resinate, 1-500.	Aug. 21	Aug. 20	Aug. 31–Sept. 4	82	82	0
19	Check.		Aug. 20	Aug. 31–Sept. 4	59	57	2
20	"Fly-skat," 1-9.	Aug. 21	Aug. 18?	Aug. 28-29	57	19	38
20	Check.		Aug. 18?	Aug. 28-29	16	15	1

Numbers in parenthesis indicate eggs lost.
Expt. 1-9, eggs on wood or paper kept in small tin boxes.
Expt. 9-20, eggs under normal conditions on bark of branches.

In the above sets of experiments no material was sufficiently effective consistently to kill 100 per cent of the eggs or enough to make any one material worthy of being considered an infallible agent in killing peach borer eggs. Eggs which were killed by the different chemicals usually collapsed as shown in plate 1, figure 3. "Scalecide" at varying strengths gave the best results, killing 40 to 100 per cent of the eggs in the different trials (Expt. 1, 2, 9, 13, 14 and 15) and the stronger concentrations were the most effective. "Scalecide" combined with crude carbolic (Expt. 2 and 9) killed 100 and 82.5 per cent. Lime-sulfur was given two trials (Expt. 4 and 10) and it killed between 20 and 30 per cent of the eggs. "Fly-skat," 1-10, (largely a creosote compound) was given several trials and the results vary somewhat. In experiment 11, 2 eggs failed to hatch out of 47 while in ex-

periments 6 and 20 about 66 per cent of the eggs were killed. A few experiments were conducted with fish-oil soap alone, fish-oil soap and crude carbolic, and laundry soap and creosol but these are not extensive enough to base any conclusions on them. Nicotine resinate was given a number of trials (Expt. 3, 12, 17, 18 and 19) at varying strengths of 1-100, 1-250, and 1-500, yet in no experiment was there a sufficient number of eggs killed to warrant the statement that this material might kill the egg. It was thought when the material was used that it might act as a stomach poison and kill the larva as it ate (apparently) its way out of the shell, but as pointed out before, the larva probably does not consume any considerable portion of the shell as it breaks through with its mandibles. Nicotine resinate has good lasting qualities and is not readily decomposed after spraying, consequently, any larva which consumes its shell would suffer if nicotine resinate were present.

The lasting effect of nicotine resinate is shown in one experiment where on July 16 the lower portions of 15 seven-year-old peach trees were sprayed with 2½ gallons of nicotine resinate, 1-100 (1 gallon for 6 trees). Small pieces of bark were removed on July 23, July 30, August 5, August 13 and August 20 from the trees which received only one treatment, and placed in a clean test tube with a small amount of distilled water and shaken. After standing for about 30 minutes the solution was filtered and a few drops of silico-tungstic acid solution were added to the clear filtrate. Immediately the solution became cloudy, having the appearance of a white milky solution. The same test, each time, was given to bits of bark removed from unsprayed check trees and in no case was there any indication of a cloudiness. The sprayed trees were tested again on September 21, but at this time there was no indication of nicotine. The above qualitative test for nicotine is recommended by Mr. V. I. Safro (see "How to Test for the Presence of Nicotine on Sprayed Plants", Jour. Econ. Ent., 1917, vol. 10, p. 459-561). The above experiment shows a definite test for nicotine on the bark of peach trees five weeks after application of nicotine resinate, 1-100.

Summary

The results in the above experiments are largely negative, so far as they may help to develop a much-needed control measure for the peach tree borer. In brief, they show the improbability of developing a poison bait for the adult, the partial repellent effect of certain chemicals on the female while ovipositing and the partial destruction of eggs when certain substances are applied as a spray. A number of experiments have been started and are now in operaion on the use of various chemical and mechanical tree protectors, but the evidence obtained thus far is insufficient to warrant a statement at this time. The author is of the opinion that the peach tree borer problem will be solved by a mechanical or chemical barrier which will kill the larva before it enters the tree or prevent it from getting into the tree. The development of any control measure along the line of killing the larva after it enters the tree is not advisable.

SMALL FRUIT INSECT INVESTIGATIONS

Strawberry Weevil

The study of 1915 and 1916 had developed the fact that keeping the strawberry buds covered with a mixture of finely ground sulfur (such as will pass through a sieve with 200 wires to the inch) and powdered arsenate of lead (5 to 1) from the time the injury begins until they open, will give adequate protection from injury by the strawberry weevil. As during neither year had satisfactory means of distributing the dust been found, with the possible exception of a screen wire sifter invented by Mr. Tony Rizzotti, of Hammonton, it seemed best in 1917 to concentrate on the problem of machinery.

Accordingly, in 1917 a test of distributing machinery was made on the farm of and in co-operation with Mr. Howard F. DeCou, of Haddonfield. The screen wire sifter proved best for small acreages, while a power duster seemed best for larger areas.

Bulletin No. 324 of ths station covering the entire problem of controlling this insect has been prepared and will soon be off the press.

Orchard Plant Lice

Attention was this year devoted to the question of destroying the eggs of each of the three common species of apple plant lice—the green apple aphis, the rosy apple aphis, and the oat aphis. Dr. Peterson discovered that the egg had at least three layers—an outer brittle transparent layer, a middle heavily pigmented layer, and an inner thin transparent envelope. He found that about one week before hatching took place the outer layer split open, and that thereafter the egg was especially sensitive to loss of moisture and to the action of various insecticides and other chemicals.

Dr. Peterson found that commercial lime-sulfur when applied to the egg at winter-strength apparently so hardened the shell that hatching did not occur. He found that a 2 per cent solution of crude carbolic acid in water to which enough soap had been added to break the surface tension destroyed the egg and caused it to shrivel. He found that the addition of 40 per cent nicotine to the lime-sulfur resulted in the destruction of a larger percentage of eggs.

In the course of some orchard tests, it was found that the thorough application of commercial lime-sulfur (1 gallon to 9 gallons of water), to which 40 per cent nicotine had been added at the rate of ¾ pint to each 50 gallons of spray mixture, to the trees just before the leaves began to project from the buds, gave a practically perfect control of the three species of plant lice.

The details of this work are set forth in another bulletin about to be published of this station and touched upon in Bulletin 328.

Rose Bug

The investigations of the rose bug were limited to the extension of the use of self-boiled lime-sulfur to peach, cherry and grape. For two years rose-bug injury to apple has been promptly stopped by a single thorough application of self-boiled lime-sulfur. This year when Mr. Warren Oley requested suggestions for control of a threatening outbreak at and in the vicinity of Vineland, the entomologist suggested a treatment with self-boiled lime-sulfur. Mr. Oley reported that this treatment gave prompt relief on peaches, grapes, and cherries.

VEGETABLE INSECT INVESTIGATIONS

Bean Maggot

For some years the growers of lima beans along the Delaware Bay coast have lost their early seeding through the action of a small white maggot. This creature which is only about ¼ inch long when fully grown, bores into and mines the seed before it has a chance to get the plant above the ground.

The species concerned appears to be the seed corn maggot (*Pegomyia fusiceps* Zett.); an insect which is recognized as occasionally injurious to bean seed in various parts of the Mississippi Valley and eastward to the Atlantic Ocean. Unfortunately, its life history is not understood, but is usually assumed to be like that of the cabbage maggot.

Assuming, because of its relationship, that it might be repelled by tar and carbolic acid, plans were made to treat the surface of the hills as soon as the early seed was planted.

The plan included two groups of treatments—the first applied just after the beans were planted, and the second to otherwise untreated rows 12 days after the seed was put into the ground.

It thus appears that the nearest to a perfect stand (47.5 per cent) was obtained by use of the tarred paper card (table 11).

Observation clearly indicated that the single treatments had been broken up or washed away by the rains. It was therefore decided to try the effect of maintaining the most promising treatments.

Table 11

Treatments and Results of Bean Maggot Investigations May 4, 1917

Row No.	Nature of Treatment	Number of beans that came up per pace	Number that should have come up	Per cent of a perfect stand
	Treatment applied the day of planting.			
1	Untreated	0.7	4	17.5
2	Tarred seed	0.7	4	17.5
3	Lime and carbolic acid (just enough of the latter to give a strong odor)	1.2	4	30.0
4	Tarred paper disks	1.9	4	47.5
5	Tarred sand	1.4	4	35.0
6	Tarred seed	0.9	4	22.6
7	Untreated	0.8	4	20.0
	Treatment applied 12 days after planting.			
1	Tarred sand	1.2	4	30.0
2	Acid phosphate	0.0	4	
3	2-12 fertilizer	0.0	4	
4	Sheep manure	1.0	4	25.0

Accordingly, on May 4, 1917, some new rows were planted. Every other row was left as a check. All materials were applied as a continuous band six inches wide. Tarred sand, whitewash, and carbolized whitewash (just enough crude carbolic to give the mixture a strong odor) were applied.

By May 28 such plants as were coming up had gotten through. Examinations made on that date showed that most of the seed had rotted in the ground and that neither checks nor treated rows were injured by the maggots. Either the planting on May 4 was made when the fly was no longer on the wing or the weather was too cold for it to be active.

It seems likely that the planting came between broods, for on this date the flies were emerging from the soil in large numbers and Mr. Moore informed the entomologist that they had been coming out for some days previous to that time.

Plantings made on this date and every week thereafter throughout the first half of the summer season showed no traces of injury

by this species and Mr. Moore reports that such has been his experience since he first began to notice the pest.

Conclusions

It thus appears that an early spring brood of flies emerges and lays eggs in the soil upon or in the vicinity of the bean seed, and that the maggots which hatch from the eggs concentrate upon the bean seed and destroy it. The problem of control in this area appears to narrow down to the prevention of injury to the early-planted seed, and the experiments indicate that much is to be hoped from the continuous wide band of tarred sand or strip of tarred paper.

GREENHOUSE INSECT INVESTIGATIONS

The Use of Hydrocyanic Acid Gas for Greenhouse Fumigation

The use of hydrocyanic acid gas for the destruction of greenhouse insects is at present greatly limited by the fear of damaging the crops on which the insects are feeding. This fear has strong foundation in the fact that many thousands of dollars worth of crops have been destroyed by improper dosages.

The dosage or the time of exposure or both must vary with the crop, the stage of development of the crop, the construction of the house and possibly with the temperature and the moisture. A great mass of facts relative to the dosage various greenhouse plants will stand has been accumulated at various experiment stations and by the United States Department of Agriculture. Also some facts bearing upon the effect of temperature, moisture and light have been gathered.

Unfortunately, the tremendous effects of house construction, especially as regards glazing and air currents, on dosage have been largely neglected. A recommended dosage that may be perfectly efficient in one greenhouse, may destroy the crop in another, or fail to kill the insects in another. The difference lies primarily in the distribution and the density of the gas atmosphere. Before much progress in determining the effect of house conditions, either a long and probably costly series of trials must be made, or some way of determining the density of the gas atmosphere must be devised.

During the past year an effort to devise an apparatus for this purpose and to make a study of the gas distribution under greenhouse conditions was begun. The work was carried on by a graduate student, Mr. W. H. W. Komp.

The essential unit of the apparatus finally settled upon consisted of one aspirator jar, a test tube absorber and glass and rubber tubing. Both the jar and the absorber were placed on a stand outside the section being fumigated but in a temperature as high as or higher than that of the house under fumigation. The rubber tubing passed into the greenhouse to be fumigated to the point where the concentration of gas was to be investigated. Enough units were employed to give an idea of the gas concentration throughout a section of the house. As many test tubes, each partly filled with one-hundreth normal sodium hydroxide solution, as there were readings to be taken were prepared for each unit.

When each of the units had been made ready, the fumigation was set. Immediately the tubing of each unit was cleared of air by drawing one liter of water from each aspirator bottle. A test tube containing the sodium hydroxide was then placed in the pipe line and the air charged with the first up-rush of gas drawn through the solution by drawing off another liter of water from each aspirator bottle. The tube was then taken out of the line and set aside. The pipe lines were then cleared by drawing off another liter from the aspirator bottle. The second test tube was then inserted in the line and another absorption made.

In this way samples of gas concentration were absorbed at short intervals throughout the course of fumigation. After the completion of the fumigation the absorbed gas was titrated with one-thousandth normal silver nitrate solution.

The upshot of the study seemed to be that the gas reached maximum general concentration within 8 minutes or less of the time when fumigation began. There was first a swift up-rush of the gas that produced a heavy concentration in the comb entirely above the insect-infested plants. The gas then distributed outward and downward until maximum general concentration was reached. Thereafter the concentration gradually decreased until it fell below the minimum dosage for the insects, or was released by opening the ventilators.

Irregularities in distribution occurred, which are at present without adequate explanation. Indeed the irregularity may be sufficient

to damage the plants if concentration is markedly greater, or to fail to kill the insect if the concentration is much less. These irregularities may be partly overcome by increasing the number of generators.

The details of the work upon which the preceding statements are based will be found in a later bulletin of this station.

SOIL-INFESTING INSECT INVESTIGATIONS

Laboratory and Field Experiments with Sodium Cyanide and Other Chemicals Against Wireworms in the Soil

ALVAH PETERSON, PH.D.

During the summer of 1916, Mr. J. P. Quinn, of the Orange City Poor Farm at Livingston, N. J., brought to the laboratory samples of potatoes and other vegetables badly injured by wireworms. A trip was made to Livingston during October, 1916, and it was noted that the 2-acre piece of land south of the home was heavily infested with wireworms. Consequently, this gave us the opportunity to try to control these insects by treating the soil with cyanide. In order that we might know how to proceed and what strength to use, a number of experiments were performed at the laboratory, out-of-doors and in the greenhouse, using soil and wireworms obtained from Livingston.

Laboratory experiments.

Sodium Cyanide. The first series (A, B, C and D) of experiments performed were conducted in small flower pots, 6 inches deep and 6 inches in diameter at the top and 3 inches at the bottom, using strengths of sodium cyanide ranging from 10 to 500 pounds to the acre. Each pot contained 5 active larvæ and was set up as follows on November 9. Four inches of subsoil was placed in each pot and 5 larvæ dispersed throughout the same. The hole in the bottom of each pot was closed by a rubber stopper. The pots in series A, B and C were buried in the ground out-of-doors in an open space near the laboratory and covered with boards to keep out the rain while the pots in series D were kept in the greenhouse; the temperature ranging between 55° and 65°F. and the moisture between 60 and 80 per cent. The temperature of the soil in the out-of-door experiments averaged about 50°F. or somewhat lower. In each series there were 7 treated pots, as indicated in the table, and one check for the series in the greenhouse and one for those out-of-doors.

In series A, including experiments 3-9, the required amount of cyanide was dissolved in 10cc. of water and poured on the surface of the subsoil, while in series B (Expt. 10-16) the necessary amount of poison was pulverized and sprinkled on top of the subsoil, but in Series C

(Expt. 17-24) and D (Expt. 25-31), the cyanide was dissolved in 175 cc. of water and poured on the subsoil. In all the above experiments, 2 inches of top soil was put over the subsoil immediately after the treatment was given.

The amounts of sodium cyanide used were 10, 25, 50, 100, 150, 250, and 500 pounds to the acre, and the exact quantity required for each pot was figured on the basis of the number of square inches (19.6) in the circular area, 5 inches in diameter, at the top of the subsoil. The following proportion gives the required amount of sodium cyanide in grams per pot: 19.6 square inches is to 43,560 square feet in an acre times 144 square inches to a square foot as the unknown *Y* is to 10, 25, 50, 100, 150, 250 and 500 pounds (changed to grams). Table 12 lists the results of the experiments after 7 days' (Nov. 9-16) exposure.

Table 12

The Effect of Sodium Cyanide on Wireworms in Four Series of Experiments A, B, C and D (Soil and Larvae in Flower Pots, November 9-16, 1916)

No. and series	Amount used and rate per acre	Larvæ alive	Larvæ dead	No. and series	Amount used and rate per acre	Larvæ alive	Larvæ dead
2-A, B, C	Check	5	0	17-C	.72 gm.,-500 lbs.	0	5
3-A	.72 gm.,-500 lbs.	0	5	18-C	.36 gm.,-250 lbs.	0	5
4-A	.36 gm.,-250 lbs.	0	5	19-C	.21 gm.,-150 lbs.	0	5
5-A	.21 gm.,-150 lbs.	1	4	20-C	.14 gm.,-100 lbs.	2	3
6-A	.14 gm.,-100 lbs.	1	4	21-C	.072 gm.,- 50 lbs.	4	1
7-A	.072 gm.,- 50 lbs.	4	1	22-C	.036 gm.,- 25 lbs.	5	0
8-A	.035 gm.,- 25 lbs.	5	0	23-C	.021 gm.,- 10 lbs.	5	0
9-A	.021 gm.,- 10 lbs.	5	0	24-D	Check	5	0
10-B	.72 gm.,-500 lbs.	0	5	25-D	.72 gm.,-500 lbs.	0	5
11-B	.36 gm.,-250 lbs.	0	5	26-D	.36 gm.,-250 lbs.	0	5
12-B	.21 gm.,-150 lbs.	0	5	27-D	.21 gm.,-150 lbs.	1	4
13-B	.14 gm.,-100 lbs.	1	4	28-D	.14 gm.,-100 lbs.	3	2
14-B	.072 gm.,- 50 lbs.	3	2	29-D	.072 gm.,- 50 lbs.	5	0
15-B	.035 gm.,- 25 lbs.	5	0	30-D	.036 gm.,- 25 lbs.	4	1
16-B	.021 gm.,- 10 lbs.	5	0	31-D	.021 gm.,- 10 lbs.	5	0

Series A, B and C in soil out-of-doors.
Series D in greenhouse.

The results of these pot experiments show some interesting and unexpected facts. The killing point in all four series is almost identical. This shows that it makes little or no difference whether the salt is dissolved or applied in crystalline or powdered form, also the difference of 10°F. in the temperature of the out-of-door and greenhouse experiments made no decided difference in the percentage killed. The larvæ were all killed in strengths of 500 and 250 pounds to the acre, and only two lived (No. 5-A and 27-D), at the 150-pound treatment while only one larva was killed (30-D) where 25 pounds and 10 pounds to the acre were used. The pots treated at the rate of 50 and 100 pounds to the acre showed, respectively, a total of 16 alive and 4 dead, and 7 alive and

The larvæ when removed from the pots were examined carefully, and as a number of them were sluggish, they were examined again in 48 hours, being kept in moist untreated soil during this period. In some cases a few recovered but the majority of the sluggish larvæ were dead at the end of the period. This fact suggested the possibility of a greater kill if the larvæ were exposed for two weeks or longer. Furthermore, it was also not known how long the treated soil would be effective against wireworms, so on November 22, two weeks after the soil was treated, in series A, B, C and D, 3 fresh active larvæ were placed in the subsoil of pots 17, 18, 19 and 20 of series C, and in pots 24, 25, 26, 27 and 28 of series D, without adding any more cyanide, and allowed to remain in these until December 7, when they were examined. All the larvæ were alive except in pots 17-C and 25-D, where one dead wireworm was found in each. This test shows the decided loss in the effectiveness of sodium cyanide after four weeks had elapsed from the time of treatment, for only pots treated at the rate of 500 pounds to the acre showed any killing power whatsoever.

The larvæ in series A, B, C and D were exposed for only 7 days before they were examined, consequently it was thought that a longer exposure might give a greater percentage of kill. Four pots (plus a check pot) each containing from 4 to 7 larvæ were treated on November 22 with sodium cyanide dissolved in 25 cc. of tap water at the rate of 100 pounds to the acre. These were examined, one at each date, on December 7, 14, 21 and January 1, and all the larvæ were found dead in each treated pot while the larvæ in the check pot were alive. These pots were kept out-of-doors during the whole period, and the temperature of the soil in which they were buried ran between 32° and 40°F., but usually 35°F. or below. This experiment shows that an exposure of two weeks or more will kill all the larvæ when cyanide is used at the rate of 100 pounds to the acre, while this was not true in previous experiments when the wireworms were kept in the treated soil for only 7 days. Temperature may have had some influence here, for it was 10°F. or more below that of series A, B, C and D, and it is possible that this may account for the greater kill, but this is seriously questioned.

If sodium cyanide at the rate of 100 pounds to the acre will kill during an exposure of two weeks or longer, possibly smaller amounts would be as effective. Four more pots were treated along with a check pot on December 8, two with sodium cyanide at the rate of 75 pounds to the acre and two at the rate of 50 pounds. These were placed out-of-doors in the soil which had an average temperature of 33°F. and one of each strength was examined on December 21 and January 6 (two week interval). On December 21 all the larvæ were dead in the pot receiving 75 pounds to the acre, while three were dead and two alive in pots treated with 50 pounds to the acre. On January 6, the pot treated with sodium cyanide at the rate of 75 pounds to the acre showed one alive and four dead, while the pot with 50 pounds to the acre gave the same results as those examined on December 21, three dead and two alive. This experiment again indicates that an exposure of two weeks or

longer will produce a greater kill than one week, and also the minimum dosage in flower-pot experiments is between 75 and 100 pounds to the acre.

The problem of how the sodium cyanide in the soil kills the wireworms was considered in connection with this study. So far as known, little or no work has been performed to determine how the wireworms or other soil-infesting insects are killed when the cyanide is introduced into the soil where they live. Are they killed by inhaling the fumes coming from the sodium cyanide, or are they killed by contact with this material in solution, or does it act as a stomach poison?

Several experiments were conducted which may throw some light on this question. On January 12 four double wire screen cages were constructed. The inner or smaller cage was made of a 3-inch strip of wire screen which was rolled to form a cylinder 1 inch in diameter and rubber corks placed in each end. A larger cage, similarly constructed, was 2 inches in diameter and made from a 5-inch strip of wire screen. The small cage was suspended within the larger cage by two strings in such a manner that no part came in contact with the outer cage and leaving a ½-inch air chamber between the inner and outer cage on all sides. Soil and several wire worms were introduced into the small inner cages of No. 1 and 3, while wireworms only were placed in the small inner cages of No. 2 and 4. All four double cages were buried in subsoil in flower pots and the subsoil in pots 1 and 2 possessing respective cages was treated in the usual manner with sodium cyanide dissolved in 25 cc. of water at the rate of 150 pounds to the acre. After treating, the pots were filled with topsoil. Pots 3 and 4 served as checks. The cages were examined on January 26 and all the larvæ in the cages removed from the treated pots were dead while those in the untreated pots were alive and active. The results of this experiment indicate that the larvæ are killed by inhaling the poisonous fumes, for the larva were removed from direct contact with the poisoned soil, consequently they could not come in contact with the same or consume poisoned particles. It is possible that the fumes might have been taken up by the moist untreated soil in the inner cage of No. 1, but this could not have occurred in No. 2, for no soil was present in the inner cage. The only possible way for the poison to have reached the larvæ would have been over the two strings which held the inner cage in suspension.

In experimenting with wireworms and sodium cyanide in flower pots measuring 6 inches in diameter at the top, 3 inches at the bottom and 6 inches deep, it was realized that the results obtained in these comparatively small and confined spaces would not necessarily hold in larger vessels or in field experiments. To determine the depth to which the poisonous effect of the sodium cyanide would penetrate the soil in sufficient quantity to kill, a number of experiments were conducted in glazed sewer pipes, 5 inches in diameter (inner space) and 25 inches long. These pipes were closed at their collar end with a circular tin disc and stood upright (collar down) in the soil on a greenhouse bench.

On January 12 fifteen larvæ were placed in each of three tiles and in a check lot. In two of the tiles, No. 1 and 2, the larvæ were distributed throughout the tile and separated from each other by round wire screen discs 5½ inches in diameter. Starting with the bottom there were 3 larvæ in the first inch of subsoil (23 to 24 inches deep) and these were confined in this space by a wire screen 23 inches from the top. Two larvæ and 5 inches of subsoil occupied the space between 18 to 23 inches from the top and at 18 inches and 17 inches there were 2 wire screens and 3 larvæ included in the soil between them. Above 17 inches and up to 12 inches 2 larvæ and soil were introduced and then again at 12 inches and 11 inches 2 wire screens enclosed 3 larvæ and subsoil. Above 11 inches and up to 6 inches deep 2 larvæ and subsoil were introduced. The top six inches of the tile was not filled until after the sodium cyanide was applied. Tile No. 1 was treated with sodium cyanide dissolved in 50 cc. of water at the rate of 150 pounds to the acre, while title No 2 received treatment of cyanide at the rate of 100 pounds to the acre.

In tile No. 3 five small cylindrical wire screen cages 3¼ inches long and 2 inches in diameter were placed in the center of the tile end to end and on top of each other; the top cage being 7 inches from the top of the tile. The cages were filled with subsoil, 3 large larvæ put in each and the space surrounding the cages filled with dirt. The sodium cyanide at the rate of 100 pounds was dissolved in 50 cc. of water and applied 6 inches from the top of the tile, and then the tile was filled to the top. The cages served the purpose of confining the larvæ to definite depths, thus making it possible to learn to what depth the poison penetrates in sufficient quantity to kill.

The above experiments were examined two weeks after they were started. In tile No. 1 where the cyanide was applied at the rate of 150 pounds to the acre it was found that all larvæ within 12 inches of the top of the tile, or 6 inches from point of treatment were dead. One or two were dead below the treated surface, but all others were alive and active. Where sodium cyanide was used at the rate of 100 pounds to the acre, all larvæ within 10 inches of the top of the tile, or 3 to 5 inches from the point of treatment were dead, while below this the larvæ were alive and active.

Since sodium cyanide would not consistently kill larvæ below 6 inches when used at the rate of 150 pounds to the acre, three other tile experiments were started on January 26, using sodium cyanide at the rate of 200 pounds (tile No. 4), 300 pounds (tile No. 5) and 400 pounds (tile No. 6) to the acre. In these experiments the wire screens were omitted, but the 15 larvæ were evenly distributed at varying depths throughout the length of the sewer pipe (6 to 24 inches). The material was dissolved in 50 cc. of water and poured upon the subsoil 6 inches from the top of the tile, and then the tile was filled with soil.

These tiles were examined on February 9. About 50 per cent of the larvæ had escaped through the lower end of the tiles into the soil on the bench, but enough remained in the upper portions of the tile to

give some clue in regard to the depth that the sodium cyanide was effective. In tile No. 4 all the larvæ 6 inches below the place of treatment (12 inches from the top) were dead, while in tile No. 5 one was alive at 11 inches from the top of the tile, or 5 inches from the place of treatment, but all others in this zone were dead. In title No. 6 all were dead above 15 inches, or 9 inches from the treated surface. The above experiments indicate that strengths of sodium cyanide greater than 150 pounds to the acre penetrate to greater depths in sufficient strength to kill. Greater strengths are more effective, but even cyanide at the rate of 400 pounds to the acre, was not strong enough to kill all of the larvæ throughout the tiles, for below 12 and 15 inches a number of active larvæ were found. In determining the depth to which sodium cyanide will penetrate in sufficient quantity to kill it is necessary to confine the larvæ to definite parts of the soil, for they will migrate considerably if this is not done.

Other Chemicals. A few other chemicals, such as lime-sulfur, sodium sulfocarbonate and pryidine, and one commercial product, "carbol-sul," which is composed of 40 to 50 per cent of carbon bisulfide, were experimented with, and will be briefly reported on at this time.

Lime-sulfur, 20°B. (3 pots) and sodium sulfocarbonate (3 pots) were used separately at the rate of 500, 250 and 100 gallons per acre. Each was diluted in 50 cc. of water put on the subsoil in flower pots as in experiments with sodium carbonate and the pots filled after the treatments were made. In another pot using lime-sulfur at the rate of 100 gallons to the acre, 10 drops of pyridine were added, also 10 drops of pyridine were added to still another pot where sodium sulfocarbonate was used at the rate of 100 gallons to the acre, and 10 drops of pyridine alone was used in one pot. In all of the above experiments there were 3 larvæ in each pot. After 7 days of exposure all were alive and active, showing the ineffectiveness of the respective chemicals.

"Carbo-sul" is manufactured by the Carbo-sul Company, Inc., of New York City and claims are made hy these people that "carbo-sul" is an effective insecticide against soil infesting insects. On January 27 ten flower pots were prepared as in the sodium cyanide experiments with 3 active larvæ at varying levels in each. These pots were kept in the greenhouse and No. 1, 2, 3, 4, 5 and 6 were treated respectively with "carbo-sul" at the rate of 500, 250, 100, 50, 25 and 10 gallons per acre. The required amount of carbo-sul was dissolved in 100 cc. of water and poured on the subsoil, and then the pots were filled with dirt immediately. In pots 7, 8 and 9 the entire pot was filled with soil and then a surface treatment was made with "carbo-sul" at the rate of 500, 250 and 100 gallons per acre by dissolving the respective quantities in 300 cc. of water and pouring the same upon the filled pots. Pot No. 10 served as a check in the above experiments.

On February 3, seven days after treating, all the pots were examined and, altogether, only 3 dead larvæ were found, two of these occurring in pot No. 1 and one in pot No. 2. All larvæ were alive and

active in pots where a surface treatment (No. 7, 8, and 9) was made. The above experiment shows the ineffectiveness of "carbo-sul" in flower-pot experiments and from our experience with sodium cyanide under laboratory conditions, it would probably be less effective in field work with wireworms.

"Carbo-sul" has a very decided odor and in the above experiments the odor disappeared within four or five days after treating while in the cyanide experiments the indistinct odor coming from sodium cyanide was detected in the soil after two weeks' exposure, especially in pots receiving the larger amounts of cyanide.

Field work

While the laboratory experiments were being performed, one field experiment was conducted at Livingston in cooperation with Mr. J. P. Quinn on December 5, 1916, and we are indebted to him for the interest shown in this problem and his willingness to cooperate with us in every possible manner. At this time the wireworms were scattered throughout the lower strata of the top soil and the upper portion of the subsoil. In the infested field the subsoil varied somewhat in depth, 10 to 15 inches, and in digging into the infested areas it was noted that the larvæ were going down and leaving behind distinct burrows through the sandy and clay-like soil. With these observations in mind, it was thought that it might be possible to kill the wireworms provided the sodium cyanide was placed at some depth in the soil and covered at once. This was done by plowing deep furrows, applying the cyanide dissolved in water and then immediately covering the treated furrows with the dirt from newly-formed furrows. With this method it seemed that the sodium cyanide or gas which it evolves might penetrate the burrows and reach the wireworms in sufficient quantity to kill.

A plot 74 by 390 feet was staked off in the heaviest infested portion (N. E.) of the 2-acre field south of the home. This was plowed to a depth of 6 to 8 inches and each furrow averaged 12.7 inches in width. Two furrows in the center were left untreated, serving as a check, while the first eight furrows on each side of the check were treated with cyanide at the rate of 100 pounds to the acre (10 pounds of sodium cyanide dissolved in 50 gallons of water and 6 gallons sprinkled in each furrow 390 feet long) and the outside 50 furrows (25 on each side) received cyanide at the rate of 150 pounds to the acre (15 pounds of sodium cyanide dissolved in 50 gallons of water and 6 gallons sprinkled in each furrow 390 feet long). The individual making the treatment walked a short distance ahead of the team of horses and plow which was making a new furrow, and sprinkled the cyanide solution into the open furrow by means of a 3 gallon watering pot, and then the plow threw the dirt into the treated furrow, thus covering the cyanide with several inches of soil almost as soon as it was applied.

At the time of treatment the temperature of the soil (6 inches) was 43°F. In about four days heavy rains came and then a cold spell which froze the land. It remained in this condition until late in the

spring making it impossible to dig into the ground to determine the effect of the cyanide treatments. On May 9 the plot was examined in various parts and it was apparent that the cyanide had not killed the majority of the larvæ but there was undoubtedly some reduction, probably not over 25 per cent. So far as observed, no difference could be detected in the two plots where the cyanide was used at the rate of 100 pounds and 150 pounds to the acre, respectively.

The majority of the larvæ on May 9, were found at the surface of the subsoil and a few in the top soil. On May 25, 1917, Mr. J. P. Quinn reported that the larvæ were up in the top soil and attacking newly planted corn, and at this time the heaviest infestation was in the southwest part of the field. On May 28 a trip was made to Livingston with Dr. Headlee and Mr. F. A. Kaufman of the Roessler and Hasslacker Chemical Company, of New York City, for the purpose of conducting some experiments on surface treatment with sodium cyanide. In cooperation with the above men and Mr. J. P. Quinn, 7 plots 12 by 18 feet were laid out with check plots between them in the worst infested portion of the field, and treated as indicated in table 13. At this time the larvæ were congregated about the corn in the various hills and within 1 to 3 inches of the surface of the top soil. The number of larvæ in each hill ran between 10 and 25 while occasionally as many as 45 were found in a hill. With the larvæ congregated in this fashion it was thought that a thorough surface treatment with sodium cyanide dissolved in water might penetrate the soil and kill the wireworms. The cyanide solution was sprinkled upon the plots from a 3 gallon watering pot.

Table 13

Plan of Field Experiment in Control of Wireworms

Plot No.	Condition of soil before treating	Amount of NaCN and rate per acre	Amount of water
1	Soil undisturbed	8 oz.= (100-lb. rate)	20 gal.
2	Raked lightly	8 oz.= (100-lb. rate)	20 gal.
3	Undisturbed and hills only treated	8 oz.= (100-lb. rate)	10 gal.
4	Raked lightly	2 oz.= (25-lb. rate)	20 gal.
5	Raked lightly	4 oz.= (50-lb. rate)	20 gal.
6	Raked lightly	6 oz.= (75-lb. rate)	20 gal.
7	Raked lightly	12 oz.= (150-lb. rate)	20 gal.

The above treatments recorded in the table were examined on June 5 and it was found that some of the larvæ were killed in the corn hills in plots 1, 2, 3, 6 and 7, but no plot showed an effective control. Plot 7 showed the greatest number dead, but these did not exceed 25 per cent of all the larvæ in the hills. The above experiment shows the

impossibility of killing wireworms by treating the surface of infested land with sodium cyanide at the rate of 25 to 150 pounds to the acre.

After the above results were obtained it was thought that the sodium cyanide must be covered and not directly exposed to the sunshine and air currents in order to be effective, consequently another large plot was plowed and treated in a manner similar to the field experiment performed on December 5, 1916. This experiment was conducted on June 5, 1917, in the same part of the field as on December 5, but the area treated was only 40 feet wide and 195 feet long and plowed to a depth of 6 inches. The field was staked off at each end at intervals of 5 feet (see diagram) making 5 furrows to each plot.

195 feet

40 feet

D	* *	150 lbs. NaCN plus ammonium sulfate	* *	D
C	* *	100 lbs. NaCN plus ammonium sulfate	* *	C
B	* *	150 lbs. NaCN	* *	B
A	* *	100 lbs. NaCN	* *	A
A	* *	100 lbs. NaCN	* *	A
B	* *	150 lbs. NaCN	* *	B
C	* *	100 lbs. NaCN plus ammonium sulfate	* *	C
D	* *	150 lbs. NaCN plus ammonium sulfate	* *	D

*Corn planted June 5.

The required amount of sodium cyanide was dissolved in 60 gallons of water and the treatments made on June 5. The solution was sprinkled into the open furrow with a watering pot, 3 gallons to each furrow, in front of a team of horses pulling a plow that filled the treated furrow at once. In plot A the cyanide was used at the rate of 100 pounds to the acre (72 ounces dissolved in 30 gallons of water) and in plot B at the rate of 150 pounds to the acre (108 ounces dis-

solved in 30 gallons of water). Plots C and D were respectively treated with cyanide as in A and B, but in addition to this treatment, a solution of ammonium sulfate was used. Ammonium sulfate with sodium cyanide probably liberates HCN (Kaufman) and thus this combination should be more effective. For plot C, 10 pounds of ammonium sulfate was dissolved in 30 gallons of water and for plot D, 15 pounds to 30 gallons of water. In treating plots C and D the sodium cyanide solution was applied with a watering pot in the usual manner and immediately followed by a similar quantity of a solution of ammonium sulfate, and then the furrow was covered at once. After all the plots were treated, the western half of the entire block was rolled in order to harden the surface of the soil and thus probably help to keep the gas within the soil. Four rows of corn, two at each end of the block, were planted across each half of the treated area, and in each row there were two hills in every plot, as indicated by asterisks in the diagram.

The above experiment was observed on June 11, and a number of active wireworms were found in all the hills of corn, regardless of the treatment given, but on the whole they were not nearly so abundant as in the infested untreated portion of the field at the west end. There was considerable variation in the number of larvæ found in the different plots, yet these differences did not accord in any definite manner with the treatments given. There was also no decided difference in the number of larvæ in the plots where the ammonium sulfate was used. This experiment shows some reduction in the number of larvæ, but on the whole the treatments did not give a satisfactory control.

On November 6, 1917, some final counts were made of the infestation in the various plots of the field by removing soil to the depth of 15 to 20 inches from areas covering nine square feet. Table 14 shows the resutls.

Table 14

Results of Field Experiments in Control of Wireworms

Plot No.	Treatment	Date of application	No. of larvæ
1	Check		16
2	150 lbs. to acre	Dec. 5, 1916	8
3	150 lbs. to acre 100 lbs. to acre	Dec. 5, 1916 June 5, 1917	11
4	150 lbs. to acre 150 lbs. to acre	Dec. 5, 1916 June 5, 1917	7

At this time the number of larvæ throughout the field was much less than in the previous year, and the table gives indication of some

reduction in the plots treated with cyanide, yet it also shows the ineffectiveness of sodium cyanide when used at strengths no greater than 150 pounds to the acre.

As a last attempt to kill wireworms with sodium cyanide a number of hills of corn, heavily infested with larvæ and in an untreated section of the field, were uncovered with a hoe on June 5 and about one quart of water, in which sodium cynaide was dissolved at the rate of 300 pounds per acre, was poured upon the larvæ within each hill and then immediately covered with soil. The same treatment plus an equal amount of ammonium sulfate was also tried on a number of infested corn hills. These hills were examined on June 11 and all the larvæ found dead, 15 to 40 to the hill. This drastic method of treating hills is apparently very effective, yet even in this treatment some of the larvæ may have been repelled by the sodium cyanide which we do not know of. The results of this experiment show that it is possible to kill wireworms if one uses large doses of cyanide and applies the material directly upon the larvæ.

In conclusion it can be said that wireworms can be killed with large quantities of sodium cyanide, but the amount necessary to bring about a satisfactory control makes this method of soil treatment too expensive for ordinary use in the field.

Since we were unable to control wireworms satisfactorily with sodium cyanide at the Orange City Poor Farm, a system of crop rotation designed to meet the problem of wireworm control was worked out by Dr. Headlee and Mr. Quinn, which will be put into operation during the coming season.

Note. We are indebted to Mr. Kaufman of the Roessler and Hasslacker Chemical Company at Perth Amboy, N. J., for the interest shown in this work and for furnishing us with the greater portion of the sodium cyanide and ammonium sulfate used in the various experiments. Also, I am indebted to Dr. Headlee for the sincere interest shown in this problem and for many valuable suggestions.

HOUSE-FLY INVESTIGATIONS

Fly Control at Beach Haven, New Jersey

Alvah Peterson, Ph. D.

For several years this department has been trying out various control measures against the house-fly and its allies and also studying their breeding and feeding habits. During 1913 an effort was made to control the flies in the city of New Brunswick, while in 1914 the problem of control was restricted to the College Farm. In 1915 and 1916 careful studies were made by Mr. Richardson on the breeding and feeding habits of the house-fly and closely related forms. For

1917 it was thought that we should take charge of the fly control work in some community, and make a practical demonstration of some of the well-known control measures. In looking about for a suitable place, we desired a small community, 500 to 3000 people, in order that one man might keep in close touch with the entire operation. It was also necessary that the place chosen be well isolated from nearby cities or places where flies might breed and migrate. Beach Haven, N. J., seemed to fulfill these requirements, so the city council was approached with the proposition and we met with a hearty response from the very beginning.

Beach Haven is a small seacoast town with a residential population of about 500 people, and during the summer months from 2500 to 3000 people. It is located at the southern end of a long narrow island (20 to 25 miles) which is several miles off the coast of New Jersey. The town is well isolated, for the nearest community of any size is Tuckerton, and this place is six or seven miles west of Beach Haven with an extensive body of water between the two places. The small communities on the island, several miles north of Beach Haven, are smaller than Beach Haven and possess few, if any, places where flies might breed abundantly. Beach Haven also has a good sewage disposal system and no out-of-door privies are permitted within the limits of the borough. The garbage is also cared for by the city, being collected at least three times a week, placed on a large barge and transported to a disposal plant across the bay. The above conditions at Beach Haven are in many respects quite ideal, thus making it possible to obtain definite results provided the remaining breeding places were cared for. These places were almost entirely confined to horse and cow stables, of which there are only eight in the borough and within one mile of its limits. The total number of animals inhabiting these places during the past season did not exceed 25 horses, 1 pony and 3 cows.

Under these conditions the control of the house-fly in this town largely resolved itself into caring for the manure and the stalls at the various stables. The first step toward fly control was accomplished in this borough on June 25 when, under personal supervision, all the stalls and breeding places (except some large piles of manure) were thoroughly treated with borax (crystals). At this time comparatively few adults were about and only a few larvæ were found under the floor boards in a few stalls, but some of the piles contained a considerable number of larvæ which were sufficient to increase the population of flies materially if not treated at once. The floor boards of stalls and other parts of the barn were examined every two weeks during the summer, and only once did any stable require more than two treatments in order to prevent breeding in these places. The manure piles were inspected once a week during June, July, and August and the breeding found was reported to the city authorities and to the caretaker when at home.

The stable men were given instructions in respect to the disposal of the manure or treating when this was necessary. In the majority of cases a hearty response was met with, but in one or two instances the desired results were not obtained by this method. It is hoped that this difficulty may be overcome in another season.

The manure was cared for in one of four ways at the different stables. The manure from two stables was removed daily (at least three times a week) and spread out on nearby gardens or vacant lots. Manure handled in this manner dries rapidly and is not suited for breeding; at least no larvæ were found in this manure. One stable man removed the manure from the stable twice a week and placed it out on the marshes where the tides kept it soaked with salty water. Another stable possessed a large cement pit and the manure was thrown into this pit and covered with water. This method was very satisfactory in eliminating breeding until the pit was filled and the manure was exposed above the top of the pit and about its margin. Under these conditions a large amount of breeding was found several times during the season and it was necessary to use borax. All manure which was not cared for according to the above methods was treated with a solution of borax at the rate of 0.62 pounds to 8 bushels of manure.

The borougb furnished each stable, where the borax treatment was necessary, with one or two large 30-gallon cans, one 10-quart watering pot and all the necessary borax for making treatments. The stable men were instructed to sprinkle 2½ gallons of solution on the daily output of manure from one horse and to make this application every day. One ounce of borax to one cubic foot of manure will kill 90 per cent or more of the larvæ and inhibit the eggs from hatching provided it is applied in solution form and the larvæ and eggs come in contact with it. It was figured out that the average output from one horse is 1½ cubic feet of manure per day and that 2½ gallons of water containing 1½ ounces of borax should penetrate all parts of this amount of manure. The large stock cans held about 30 gallons of solution (18 ounces of borax) and this was sufficient to make 12 treatments for one horse. In making treatments it was noted that wet manure which had been soaked by rains or when located in low wet areas was difficult to treat, for it was next to impossible to make any additional water (by sprinkling) penetrate the wet manure. When manure is in this condition, particularly in low wet areas, and contains numerous larvæ, it should be put on higher ground in order that it may dry out somewhat; or a thick layer of gravel or cinders placed under the manure in wet and low areas will help considerably.

At the beginning of the season we planned to use hellebore in treating infested manure, but this cost 30 cents a pound on the Philadelphia market while borax could be purchased in 100-pound lots at 9 cents a pound. Manure treated with borax is detrimental to some plants when the manure is used as a fertilizer, but, so far as known, it will not injure plants provided one does not use over 15 tons of treated manure

In the weekly inspections the manure piles were carefully examined and also a lookout was kept for dead fish and garbage which might breed blow files and the like. One striking thing noted in respect to the adult flies about the town was the small percentage of common house-flies and the large percentage of stable and blow flies. Undoubtedly the latter came from dead fish scattered here and there on the beach, in the marshes and about the town. At times the garbage was not disposed of as rapidly as it should have been and occasionally the cans were alive with blow-fly larvæ breeding in meat and fish. The control of blow flies is a matter of proper disposal of all decaying meat and dead fish.

Besides caring for manure, fly traps and poisoned baits were used during July and August, but these indoubtedly played only a minor part in the efforts made toward the control of flies. Poisoned baits gave some promise of becoming an important factor in fly control.

Fly Traps. Wire fly traps, 10 inches in diameter and 10 inches high, were furnished the various stables one hotel and one restaurant. Comparatively few adults were captured during the season, and so far as observed, tbe traps were of little value in controlling the flies. Possibly a larger trap might have given better satisfaction. The traps were baited once a week by placing decayed bananas and molasses in a paper plate beneath the trap.

Poisoned Bait. At the outset it was planned to make an extensive investigation of poisoned baits but other work would not permit. It is desirable to find a poisoned bait which is attractive to adult flies, easily applied, with good lasting qualities and which kills rapidly. Experiments were conducted with only one bait (sodium arsenite, molasses and water) which has recently been used by C. W. Malley with good results in Africa.

A number of experiments were conducted in small round traps, 6 inches in diameter and 9 inches high, with the above bait. It was applied to the sides of the cage by means of a brush and the flies within readily consumed the bait. After a fly had partaken of the poisoned solution it required from 1 to 6 hours or more for the poison to kill. Table 15 shows the results of one of a number of similar experiments that were performed for the purpose of determining the effect of the varying strengths of poison and the amount necessary to kill. In this experiment the designated amount of sodium arsenite was dissolved in one-half the necessary amount of water and then an equal amount of corn syrup ("Karo") was added. The experiment was started on July 13 at 11 A. M. and continued until 7 A. M. the next day. Each trap possessed one or more individuals of *Stomoxys calcitrans, Musca domestica, Calliphora erythrocephala, Lucilia sericata, Phormia regina, Fannia canicularis* and other species but 75 per cent of the flies were *Stomoxys calcitrans.*

Individuals of all species consumed some of the poisoned bait and died. The table shows that all the strengths used, 1 ounce to 1/8 ounce of sodium arsenite per gallon of solution, were sufficient to kill, but the rapidity of kill was considerably higher with the greater

strengths and also the percentage killed (in 20 hours) was somewhat greater. An examination of the number of dead at 2 P. M. shows clearly the rapidity of kill for the various strengths. Since the above poison acts slowly in killing the adults this undoubtedly accounts for the fact that comparatively few dead flies may usually be found near the bait when used on a barn or otherwise. In other words, the fly may go some distance before it dies.

Table 15

Effect of Poison of Varying Strength on Flies

No.	Strength of arsenite	Dead 12 a. m.	Dead 1 p. m.	Dead 2 p. m.	Dead 3 p. m.	Dead 4:30 p. m.	Dead 6 p. m.	Dead 7 a. m.	Alive 7 a. m.	Total flies
1	1 oz. to 1 gal.	0	2	10	14	14	17	20	2	22
2	½ oz. to 1 gal.	0	3	8	9	12	15	17	13	30
3	¼ oz. to 1 gal.	1	1	6	9	12	12	17	5	22
3	⅛ oz. to 1 gal.	0	1	4	6	10	13	20	12	32
5	Check, molasses only	0	0	0	0	0	0	0	20	20

The poison bait used by C. W. Malley in South Africa contained 1 pound of sodium arsenite, 2 gallons of cheap molasses and 10 gallons of water. This mixture is very thin and was found to dry rapidly on exposure to air, and on hardening was not as attractive as when moist. The above bait was thickened by using equal amounts of molasses (or syrup) and water, and adding sodium arsenite at the rate of 1 ounce to 1 gallon of solution. Even this concentration of molasses would harden in the course of three of four hours, especially on a warm day when exposed to the direct rays of the sun. It was found that the addition of honey (honey 25 per cent, molasses 25 per cent and water 50 per cent) would keep the bait from hardening rapidly, but the use of honey would probably be unsafe in territories where bees are present. Flies are attracted in considerable numbers to freshly applied bait, but compartively few can be found on hardened bait, consequently it is desirable to find some material which will not dry out and harden rapidly but retain its moisture and remain more or less sticky. So far nothing satisfactory has been found outside of honey.

The bait was applied at the various stables in the borough. A 2-quart pail and an ordinary paint brush were furnished and the stable man was asked to make a daily application of the material to the sides of the barn, fences or sheds where flies naturally congregate in

considerable numbers. At two of these stables bunches of straw were dipped into poisoned bait and suspended above the manure piles. It was noted that a considerable number of flies visited these bundles, especially when the bait was fresh and sticky.

Just how many flies or what proportion of the adults were killed by the use in the borough of poisoned baits is unknown. In some definite trials it was undoubtedly effective. During the latter part of July *Stomoxys calcitrans* and other species, including green-headed flies, were particularly abundant in a private garage in the southern part of the town (garage adjacent to a stable) so the mechanic made use of the poison bait by brushing a goodly quantity of the material on the screens in the windows. On the following day the majority of the flies had disappeared and numerous dead flies could be seen about the garage and on the window sill. Among the dead flies were a number of green-headed flies which the man claims readily consumed the bait.

So far as can be observed, it may be said that flies were by no means so abundant at Beach Haven in 1917 as in the previous season. Whether this was due entirely to the control measures used or to weather conditions and parasites we are unable to say. The only way definitely to determine the ffectiveness of the control measure will be by carrying on these various measures for several seasons. In making the weekly inspections, it was noted that adults were abundant twice at one stable and once at another and these outbreaks were predicted on the basis of conditions at the respective barns some ten days previous to the appearance of the adults. Numerous comments by people who had lived for a number of years in Beach Haven all confirmed the fact that the flies were not as abundant as in former years. This was particularly true at one hotel where only a few flies could be found about the kitchen while in previous years it was said to be fairly black with adults throughout most of the summer. The experience of the past season should help considerably in combating this insect in 1918.

Note. We are particularly indebted to Mr. Ireland and Mr. Engle for the interest shown in the problem and their constant attention to necessary enforcement of treatments, etc. We also wish to express our thanks to those men in particular who cared for their manure in the proper manner and thus eliminated breeding in their piles. Personally, I am indebtedly to Dr. Headlee for the cooperation shown in this work and for the many valuable suggestions received.

REPORT ON MOSQUITO WORK

THOMAS J. HEADLEE, PH.D.

PREVIOUS TO 1917

The map which follows will serve to show in a graphic way what has been accomplished in salt-marsh drainage by all agencies up to 1916-1917, and the effect of this work on the prevalence of the salt-marsh species (fig. 1).

The migration of the salt-marsh mosquitoes over the upland is shown by dots, in the places and in relative abundance as indicated by last year's reports.

The occurrence of infested areas in the region of the salt-marsh which is marked drained is due to the incompleteness of the drainage system installed.

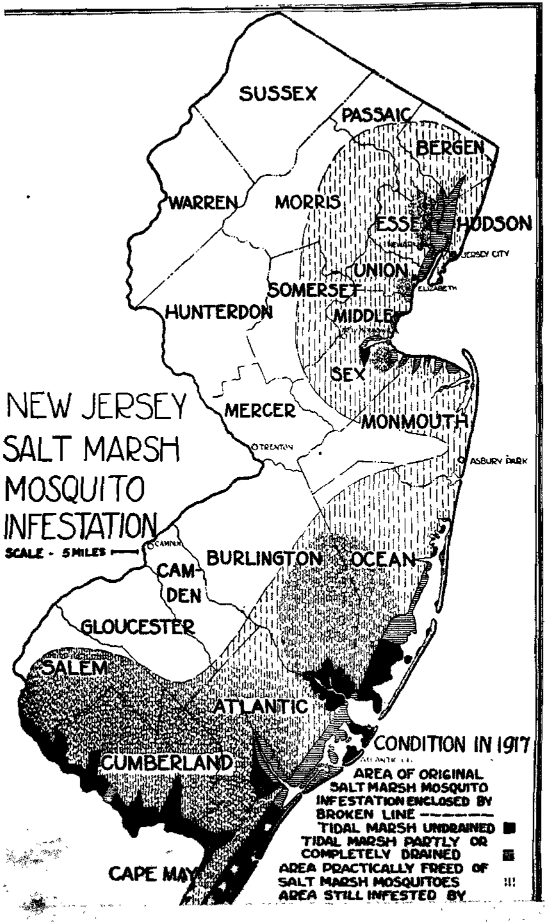
Anything like complete elimination throughout this large area involves the installation of more complete drainage systems than now exist in more than a very few places. For the purpose of showing lack of completeness in the drainage system, table 1, giving estimates prepared about January 1, 1917, is presented.

Table 1

Status of Salt-Marsh Drainage in New Jersey, January 1, 1917

County	Total area acres	Drained or not in need of draining per cent	Undrained per cent
Hudson	11,468	56	44
Bergen	8,378	60	40
Essex	4,621	98	2
Union	4,413	90	10
Middlesex	8,199	50	50
Monmouth	3,378	60	40
Ocean	40,400	60	40
Atlantic	53,325	55	45
Cape May	53,638	11	89
Cumberland	52,661	4	96

In Bergen, the lower end of Ocean, Atlantic, and Cape May as well as in certain limited areas in other counties the ground which was covered was sufficiently drained, and the percentage



NEW JERSEY
SALT MARSH
MOSQUITO
INFESTATION
SCALE - 5 MILES
SUSSEX
PASSAIC
BERGEN
WARREN
MORRIS
ESSEX
HUDSON
JERSEY CITY
UNION
ELIZABETH
SOMERSET
HUNTERDON
MIDDLESEX
MERCER
TRENTON
MONMOUTH
ASBURY PARK
CAMDEN
BURLINGTON
OCEAN
GLOUCESTER
SALEM
ATLANTIC
CUMBERLAND
CAPE MAY
CONDITION IN 1917
AREA OF ORIGINAL SALT MARSH MOSQUITO INFESTATION ENCLOSED BY BROKEN LINE
TIDAL MARSH UNDRAINED
TIDAL MARSH PARTLY OR COMPLETELY DRAINED
AREA PRACTICALLY FREED OF SALT MARSH MOSQUITOES
AREA STILL INFESTED BY

touched. In the other counties, however, with the limited areas expected, the shortage is due to lack of completeness within areas already covered by drainage systems.

The same point is shown by the fact that the average number of linear feet per acre in the area covered is about 120, while rather careful investigations of the past three years have shown that about 300 linear feet of 10x30-inch ditching, or its equivalent, per acre is necessary to effect mosquito drainage in open salt meadows. In sections shut in by railway grades, roadways, and fills the number of feet required may be less, but the cost of dike, sluice, and tide-gate construction, or the installation of pumps and the maintenance of all will more than offset the difference.

Although not by any means complete, the amount of work accomplished is large and the results in mosquito control gratifying. About January 1, 1917, a general statement of the work up to that time was prepared, which reads as follows:

"Approximately 95,000 acres of salt marsh have been rendered reasonably free from mosquito breeding. This has involved the cutting of 11,500,000 feet of ditches 10 inches wide and 30 inches deep, or their equivalent, the building of 17.2 miles of dike, the installation of 76 sluice and tide-gates (representing 842 square feet of cross section outlet opening), the installation of one 4 and one 12-inch centrifugal pump and the connection of 100 acres of marsh with a large sewage pumping plant.

"The best testimony as to the efficiency of the work is the fact that not a single brood of mosquitoes of any consequence has emerged during the past season (1916) from the 95,000 acres which have been drained."

Previous to 1912 the burden of salt-marsh drainage was borne by the State of New Jersey, through its Agricultural Experiment Station, alone and in some cases in cooperation with certain municipalities such as Jersey City, Newark, and Elizabeth. In 1912, however, the county mosquito unit was authorized and local effort became at once pronounced. With the county unit come the regular maintenance of the trenching already cut and the establishment of new drainage systems. In 1912 Essex and Union counties began. In 1913, Hudson, Passaic and Atlantic became active and Essex and Union continued. In 1914, Bergen, Middlesex, Monmouth and Ocean began and the others continued. In 1915 Cape May took up the work and the others continued. Local efforts were under-

taken in Somerset, Mercer and Camden but in every case the problem of mosquito control was found to be local and not of sufficient importance to merit county-wide activity.

The salt-marsh work of a drainage character done by the counties soon reached and passed the state's efforts. At the beginning of the county work (1912) the state was doing about 75 per cent and the counties 25 per cent of the salt-marsh drainage, while in 1915 the state was doing 28 per cent and the counties 72 per cent, and in 1916 they were doing all of it.

While endeavoring to economize on state expenditures during the winter of 1915-16, the Legislature provided only $4,800, just enough to keep the force together, and consequently no new drainage work could be undertaken by the State Agricultural Experiment Station.

Table 2

Salt-Marsh Ditching in New Jersey, 1912-1916

Year	Experiment Station Ditching		County Commission Ditching	
	No. of feet cut	No. of feet cleaned	No. of feet cut	No. of feet cleaned
1912........	1,036,188*		239,800	470,000
1913........	689,842	Minimum amount	879,365	1,300,000
1914........	321,601	None	1,057,167	919,000
1915........	745,105	None	1,971,242	3,171,128
1916........	None	None	2,542,713	500,000**

Many of the county units undertook the control of fresh-water species as well as those which bred on the salt marsh. This was true of Hudson, Bergen, Essex, Union, and Atlantic counties. Passaic had no salt marsh and so devoted its entire attention to the fresh-water species.

One portion of the statement mentioned on page 487 bears on the volume of fresh-water work accomplished. "Approximately 50 per cent of the reasonably permanent fresh-water mosquito breeding pools, scattered over 315,000 acres of upland, have been per-

*Maximum figures, probably 25 per cent or more too high.
**Blockage was removed from the entire system; the above includes complete cleaning only.

manently eliminated. Approximately 315,000 acres of upland have been likewise patrolled (during 1916) and as nearly as possible all residual breeding destroyed."

Throughout the development of the county work the anti-mosquito knowledge and force of the State Agricultural Experiment Station has been at the command of the county units and has been very freely used by them.

WORK OF 1917

Mosquito Control Work of the State Agricultural Experiment Station—Salt-Marsh Drainage

Two pieces of drainage work were undertaken and carried out during 1916-17. One was located in Upper Township of Cape May County on both sides of Beesley's Point and another in Little Egg Harbor Township of Ocean County on the marsh lying about Well's Island.

Upper Township, Cape May County Work. The area laid out for drainage extended from the Meadow Boulevard west of Peck's Bay northward along the upland to Beesley's Point and southward along the west side of the upland from Beesley's Point to Schooner Creek. More than half that portion of the area lying east of the upland was already covered by drainage systems, but it was included with the thought that such additions as might be necessary to complete could be made. As a matter of fact, the marsh owners were so opposed to such action that it did not seem practicable to make any addition to the system as already established, especially in view of the fact that the drainage was reasonably good as it stood.

Bids were called for and Mr. Harold I. Eaton, having submitted the lowest bid, was awarded the contract on February 7, 1917, for 100,000 linear feet of ditching, 10 inches wide and 30 inches deep, or its equivalent, for the sum of $2,400. By "equivalent" is meant ditches of greater width or less depth reckoned on the basis of the standard 10x30-inch ditch.

The actual work of drainage began at the point where the last work left off, continued northward to Beesley's Point and from thence southwestward as far toward Schooner Creek as the funds

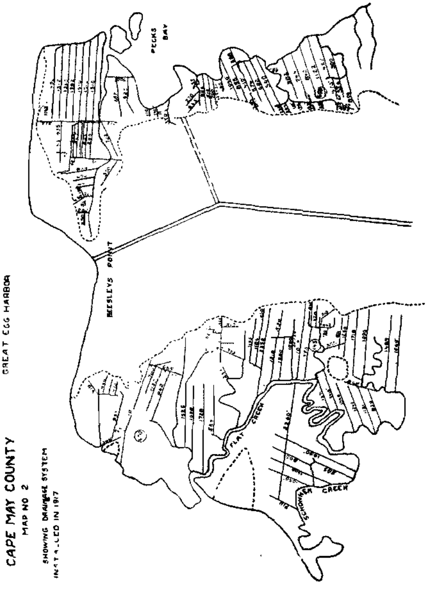


FIG. 2. Map of the drainage established in Upper Township of Cape May County.

could permit. Not as much spur ditching was cut as the type of salt marsh demanded, but quite as much was put in as could be installed and allow us to live on terms of amity with the small owners. (Fig. 2.)

All told 99,579 linear feet of 10x30-inch, or its equivalent, of main ditching was put in and 2,408 linear feet of spur ditches were cut. The system thus established covers 650 acres.

Little Egg Harbor Township, Ocean County Work. The area laid out for drainage practically surrounds Well's Island and included all that territory between the Mullica River and Great Bay on the one hand and Deep and Roundabout Creeks on the other.

Bids were called for and Mr. Harold I. Eaton's proposal, being the lowest of all submitted, was accepted and a contract for cutting 114,285 linear feet of 10x30-inch ditching, or its equivalent, was let for the sum of $2,400 on April 24, 1917.

As a matter of fact, the footage contracted for failed to cover the whole of the areas as above outlined. It covered the marsh surrounding Well's Island only and included about 640 acres.

Although parts of the area were such as to demand a large amount of spurring, very little was put in because it was thought that the Ocean County Mosquito Extermination Commission could do that more cheaply with its own labor. The Commission agreed thus to supplement the ditching system established. After the contracted amount (114,285 feet) had been cut 5,220 feet additional for the purpose of securing better outlets were cut at a labor cost of $100. All told 119,505 linear feet of ditching was cut by the State Agricultural Experiment Station on this area.

The nature and the arrangement of the system thus established are shown in figure 3.

Table 3 serves to show year by year the amount of salt-marsh drainage that has been established. Up to 1913 the amount stated is based upon estimates for the most part. Beginning in 1913 the amount of drainage stated is based on measurements. It has been deemed advisable to omit the acreage because so much of the drainage is placed in areas already covered by inadequate drainage systems. The cost of administration up to 1913 included the difference between the contract price of ditching and the total amount expended. With the formation of the county commission unit, local interest in mosquito control became such that expenditures for salaries, traveling, preparation of plans and matters necessary there-

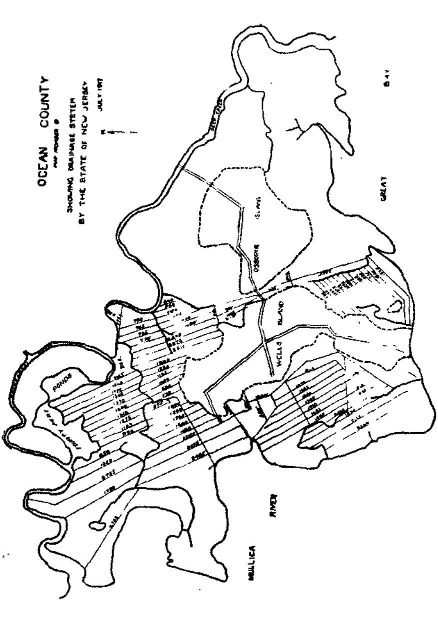


FIG. 3. Map of the drainage established in Egg Harbor Township of Ocean County.

to increased to a point where the difference between the money spent for ditching and the total expenditure could not be justifiably charged to administration of salt-marsh drainage. In 1913, 1914, 1915,

Table 3

Statement of Salt-Marsh Drainage from the Beginning to and Including the Year 1917

PERIOD	Acres	Feet of ditching	COST TO THE STATE			
			Ditching	Necessary studies and publications	ADMINISTRATION For actual ditch cutting	For other purposes of the act
Up to 1907, as reported	15,851	2,215,624		$11,000.00		
In 1907, as reported...	10,951	1,505,524	$19,400.00		$4,100.00	
In 1908, as reported...	6,669	883,650	15,758.00		4,242.00	
In 1909, as reported...	2,672	365,800	9,917.00	539.00	4,543.00	
In 1910, as reported...	4,650	350,000	4,471.00		2,528.00	
In 1911, as reported...	8,528	712,000	19,650.00		5,350.00	
In 1912, as reported...	6,195	1,000,180	21,650.00		3,350.00	
In 1913, as measured..	7,174	1,564,842	21,580.00		4,026.70	$4,393.30
In 1914, as measured..		1,293,840	7,533.86		5,213.65	2,224.09
In 1915, as measured..		2,686,071	13,426.25		4,085.40	1,500.00
In 1916, as measured..		2,643,713			2,378.86	1,800.00
In 1917, as measured..		2,397,869	4,900.00		2,772.00	2,295.81

Table 4

Statement of the Salt-Marsh Drainage Work Done by the State Experiment Station and the County Mosquito Extermination Commissions

Date	*Experiment Station Ditching*		*County Commission Ditching*	
	Number of *feet cut*	Number of *feet cleaned*	Number of *feet cut*	Number of *feet cleaned*
1912........	1,036,180*		239,800	470,000
1913........	689,842	Minimum amount	879,365	1,300,000
1914........	321,601	None	1,057,167	919,000
1915........	713,823	None	1,971,248**	
1916........	None	None	2,542,712	
1917........	321,492	None	2,176,492	

1916 and 1917 an attempt was made to charge that portion which it seemed should properly belong to salt-marsh drainage under that head. In 1916 the only salt-marsh drainage work consisted of the finishing of contracts let the previous year.

*Maximum figures, probably 25 per cent too high.

**In 1915 the practice of going over every foot of the entire system obtained.

The large number of feet listed for the present and the past several years is due to the work of the county mosquito commissions in their attempt to drain the salt marshes that come within the limits of their counties. Table 4 serves to show this point.

Aid Extended and Surveys Made

During the year the entomologist has made 87 trips to various points in the interests of mosquito-control work, occupying approximately 108 days.

Two surveys were made—the first a fresh-water problem at Allamuchy Lake and the second a salt-marsh problem at Sea Isle City.

Allamuchy Lake Report. The lake itself is an artificial pond caused by damming across a narrow valley. As is customary with such lakes the head of it is shallow and runs out into a typical marsh. The sides are timbered to the very water's edge and many trees have fallen over into the water. Just above the lake (No. 1) is another dam and another lake (No. 2) which is about one-fourth the size of Lake No. 1. The marsh above is about the same size as the marsh adjoining the first lake. Just beyond the camp buildings, that is ,southwest of the camp, is another inlet with its corresponding marsh.

The following procedure was advised:

(1) Lake No. 1
- (a) Clear edges of all vegetation and fallen timber and stock with fish.
- (b) Cut main outlet through marsh at its head, either dig or dynamite.
- (c) Clear all inlet streams of any obstruction and drain swamp southwest of the camp.

(2) Lake No. 2.
- (a) Lower surface of lake by taking out 3 feet of dam so as to drain marsh near upland.
- (b) Keep camp clear of all tinware and crockery so that there may be no standing water in the camp.

The woods within a radius of one mile of the camp should be inspected and all woodland pools be located and either filled or drained.

Mosquitoes may fly from the large marsh areas about Waterloo, or from the marsh just beyond the divide above the camp, but these may be drained in the same manner as the other marshes by a deep straight central outlet.

Sea Isle City Report. The area concerned in this report is that part of Ludlam Beach which extends from the point where the West Jersey and Seashort Railroad enters to Corson's Inlet. In this section the natural drainage of the beach is greatly interfered with by the roadway and the roadbeds of the West Jersey and Seashore and Atlantic City Railroads.

The purpose of the plan and specifications which follow is to relieve this congestion and re-establish effective drainage.

The proposed drainage system is planned to carry all the surface water off the marsh inclosed by the railroads. The railroad culverts are all placed 30 inches below the surface of the marsh throughout plan I and 24 inches below the surface in plans II and III, and are so provided with ditches that the water may run out with every low tide. The most northerly culvert has a special grade.

The culverts under the street shall be placed as low as possible without actually digging into the sand itself. The ditches must be so graded as to carry the standing water out readily.

The plan of this system has been drawn to an approximate scale of I inch equal to 200 feet. The streets, etc., were taken directly from the tax maps; and the switches, the marsh line and some of the creek outlets were sketched in on the ground. All are approximately correct.

The plan calls for a ditch between the Atlantic City Railroad and the West Jersey and Seashore Railroad throughout the length of the marsh, except where the fills are over 50 feet in width and in such places this ditch is omitted. The same applies to between the West Jersey and Seashore Railroad and the trolley, and between the trolley and Commonwealth Avenue on maps II and III.

The ditching east of Commonwealth Avenue is merely indicated, the exact location is to be staked as the work starts.

Drain No. 1 is located just across Landis Avenue from House Street. It is a 20 by 30-inch ditch. It goes under the West Jersey and Sea Shore Railroad tracks 6.2 feet below base of rail and under the Atlantic City Railroad 2.8 feet below base of rail and outlets into Beach Creek.

Drain No. 2 consists of a 20 by 30-inch ditch under Landis Avenue, 75 feet north of Matilda Street. It runs as far but does not cross the West Shore and Seashore tracks.

Drain No. 3 consists of a 20 by 30-inch ditch, starting 100 feet east of Landis Avenue just north of Farrand Street. From there it runs in a westerly direction crossing Landis Avenue and crosses the West Jersey and Sea Shore Railroad 6.2 feet below base of rail and the Atlantic City Railroad 2.8 feet below base of rail. It then continues across the marsh and outlets into Swimming Creek.

Drain No. 4 is a 20 by 30-inch ditch crossing Landis Avenue just north of Elm Street. It outlets into the middle ditch and runs as far as the West Jersey and Seashore Railroad tracks.

Drain No. 5 is situated 600 feet north of Drain No. 4. It starts 75 feet east of Landis Avenue and crosses Landis Avenue running in a westerly direction across the West Jersey and Seashore Railroad at a grade of 6.2 feet below base of rail and across the Atlantic City Railroad 2.8 feet below base of rail, thence across the marsh into Swimming Creek.

Drain No. 6 runs parallel to Drain No. 5 and is situated 500 feet north of it.

Drain No. 7 starts 200 feet east of Landis Avenue just north of Prospect Street. It crosses Landis Avenue by culvert and under the freight switch of the West Jersey and Seashore Railroad. Thence it crosses the main track of the West Jersey and Seashore Railroad 6.2 tenths feet below base of rail and the Atlantic City Railroad 2.8 feet below and thence across the marsh into Swimming Creek. A branch from Drain No. 7 crosses Prospect Street by culvert and drains the block east.

Drain No. 8 is located just south of proposed Philadelphia Street. It crosses Landis Avenue by culvert and thence crosses the West Jersey and Seashore tracks 5.2 feet below base of rail and across the Atlantic City Railroad 2.8 feet below base of rail and thence across the marsh and into Ludlam Bay.

Drain No. 9 is 1300 feet north of Drain No. 8. It crosses Landis Avenue, the West Jersey and Seashore Railroad at a grade of 5.2 feet below base of rail, the Atlantic City Railroad at a point 2.2 feet below base of rail thence across into Ludlam Bay. As this part of the cut is through sand, it must be made with sloping sides and should be 3 feet wide and 2 feet deep.

Drain No. 10 is 1400 feet north of Drain No. 9 and otherwise similar to it.

Drain No. 11 is 1500 feet north of Drain No. 10 and otherwise similar to it.

Drain No. 12 is 1650 feet north of Drain No. 11. It crosses Landis Avenue and thence across the West Jersey and Seashore tracks at a point 5.2 feet below base of rail and across the Atlantic City Railroad 2.8 feet below base of rail, directly across the marsh into Ludlam Bay.

Drain No. 13 is just north of the Whale Beach switch. This crosses the trolley tracks and the West Jersey and Seashore tracks through old culvert No. 7, which is low enough to drain low spots between Commonwealth Avenue and the West Jersey and Seashore Railroad. The Atlantic City Railroad crossing must be 2.8 feet below base of rail, however, and then directly across into Ludlam Bay.

Drain No. 14 is located 1400 feet north of Drain No. 13. It crosses Commonwealth Avenue, the trolley, the West Jersey and Seashore at a grade of 5.2 feet below base of rail and the Atlantic City Railroad at a grade of 2.8 feet below base of rail, thence directly across into Ludlam Bay.

Drain No. 15 is 1600 feet north of Drain No. 14 and drains into the pond, outlets and grade remaining the same.

Drain No. 16 is 900 feet north of Drain No. 15 and runs at the same grade across the railroad emptying into the pond.

Drain No. 17 is just south of Prescott Avenue. It crosses Commonwealth Avenue, the trolley tracks, the West Jersey and Seashore Railroad at a grade of 5.2 feet below base of rail and the Atlantic City Railroad at 2.8 feet below base of rail, thence across the marsh into Strathmere Bay.

Drain No. 18 is at the northern end of Strathmere. It has two culverts across Commonwealth Avenue, one across Willard Road and then it runs as a railroad ditch to a point 75 feet north of Webster Road where it crosses the railroad at a grade of 5.8 feet below base of rail. Then it crosses sand hills where the sides must be kept in place by planks 1 inch thick on each side. It is dug thus for 200 feet, crosses Bay View Drive and opens directly into the Bay. Grade stakes are given for all road culverts in this drain.

Cross drains as given are connected by cross ditches in many places. These are shown on the maps.

There are at present 10 culverts under the West Jersey and Seashore Railroad tracks as they cross the tidal marsh from Hartson Street, Sea Isle to the Corson Inlet Station, Strathmere. These do not include the street culverts in Sea Isle proper.

Culvert No. 1 is located at the most southerly part of the marsh. It is just north of the fill on which Hartson Street is to be built. It consists of a round iron culvert about 10 inches in diameter, the bottom of which is probably 4 feet below the top of the rail. There is a comparatively good ditch leading to it but the ditch leading from it is badly choked with cinders, sand and weeds. The situation is very bad if a drainage into the Atlantic City Railroad culvert is to be considered.

Culvert No. 2 is located about 800 feet north of Culvert No. 1. It is set with the bottom approximately 5 feet below the top of the rail at this point. At present there is 1 foot of water standing in it as a result of no outlet. It opens at a point where it would have to cross two switches in order to go straight to any good outlet. It is an iron culvert 2 feet in diameter.

Culvert No. 3 is an old box culvert set about 250 feet south of Prospect Street Station. This needs lowering to grade.

Culvert No. 4 is an old wooden culvert set just opposite Philadelphia Avenue. This is a box 18 by 12 inches and set 4 feet below the top of the rail.

Culvert No. 5 is just about 100 feet north of Culvert No. 4. It is a wooden box and is unnecessary if Culvert No. 4 is lowered.

Culvert No. 6, is located just south of the switch at Whale Beach. This is a very small 6 by 10-inch box culvert set 4 feet below the top of the rail. This needs lowering and an increase in size.

Culvert No. 7 is located just north of Whale Beach switch. This is cast iron protected on the west side with terra cotta. It acts as a street culvert for the road crossing at this place and if proper outlet and inlet were furnished it would be in very good shape.

Culvert No. 8 is located opposite Emerson Road. This is a wooden box culvert set 4 feet below the top of the rail. It is open for its entire length but needs lowering.

Culvert No. 9 is situated in line with Franklin Road. It consists of a box culvert which is set 4 feet below the top of the rail. It is not able to drain the ponds properly until it is set lower and provided with a proper outlet.

Culvert No. 10 is situated just opposite the center line of Otis Avenue. It is an iron pipe set 4 feet below the top of the rail. No good outlet has been provided so that it has rapidly become filled. It is low enough at this point, but a much better place to drain would be just south of Prescott Street (one block north of Otis). Here the old grade of 5 feet below the top of the rail would be sufficient.

The culverts under the triangular switch of the Atlantic City Railroad near Matilda Street are all good, but those under the main line are all worn and broken, the only active one being at a point 200 feet north of Culvert No. 1 on the West Jersey and Seashore Railroad. The other culverts are all broken, and all need resetting.

The culverts in the triangle switch near Sea Isle are new and are draining the inclosed marsh well.

Taken as a whole, the grade of the bottom of the Atlantic City Railroad culverts should be 2.18 feet below the base of the rail and they should be arranged so that they will be opposite those proposed for the West Jersey and Seashore tracks.

Financial Statement of State Experiment Station's Mosquito Work

Total appropriation		$10,000.00
Salt-marsh ditching (contracts and incidental labor)	$4,900.00	
Advertising for proposals	32.37	
Equipment	307.69	
Telephone and telegraph	30.25	
Postage	65.00	
Salaries of regular and temporary employees	3,135.00	
Traveling expenses	1,300.30	
Clerical and laboratory assistance	65.00	
Labor and technical assistance	82.20	
Reverting to State Treasury	82.19	
		$10,000.00

County Mosquito Extermination Commission Work

Hudson, Bergen, Essex and Union have continued their efforts to find and destroy all mosquito breeding which occurs within their limits. Passaic did the same work for the territory covered by the cities of Paterson and Passaic and adjacent boroughs. Middlesex, Monmouth, Ocean and Cape May have devoted their whole attention to the suppression of salt-marsh breeding. Atlantic has given primary attention to the suppression of breeding on her salt-marshes but has also made an effort to suppress the local fresh-water species in Atlantic City and other towns and cities of the county.

Hudson County

The plan of discovering by regular examinations of all parts of the county all mosquito breeding and of destroying it in so far as possible has been continued during the present year. The effort to eliminate the reasonably permanent breeding places in a permanent manner by proper drainage and filling has been continued to the extent of the commission's funds.

During March and April the entire drainage system was thoroughly gone over and cleared wherever thought to be necessary. About 700,000 feet of marsh trenching were thus put in shape for the summer.

During the season 109,943 linear feet (reckoning on the basis of ditches 10 inches wide and 30 inches deep) of ditching was done. Most of this was cut in areas filled with old cedar stumps and was both difficult and expensive to install. The detail of this work is indicated in the following statement:

Apr. 12. J. C. Meadows west of West Side Park, 15,000 ft. at 2½ cents per ft.

May 10. Dennis property, Belleville Turnpike, stump-lot ditching, 2,120 ft. at 7 cents per ft.

Pest House, Snake Hill, for County Board of Health, 826 ft. at 2½ cents per ft.

J. C. Meadows, 2,507 ft. at 2½ cents per ft.

County Road near P. R. R., 2,235 ft. at 2½ cents per ft.

County Road near P. R. R., 1,835 ft. at 7 cents per ft.

Harrison Turnpike & D., L. & W. R. R., 3,266 ft. at 2½ cents per ft.

Saw Mill Creek, stump-lots, 5,200 ft. at 7 cents per ft.

May 25. Kearny Meadows, north of Belleville Turnpike, stump-lots, 17,100 ft. at 7 cents per ft.

Same ditch, clear, 483 ft. at 2½ cents per ft.

Clear Meadow ditches, parallel with Harrison Turnpike, 4,460 ft. at 2½ cents per ft.

June 14. New Ditch, Saw Mill Creek section, 10,570 ft. at 7 cents per ft.
Repairing old ditch from P. R. R. west to pump, 6,850 ft. at 5 cents per ft.
Repairing stump-lot ditch, P. R. R. east to Dead Horse Creek section, 2,400 ft. at 7 cents per ft.

July 12. Stump-lots, Saw Mill Creek, 15,372 ft. at 7 cents per ft.
Dead Horse Creek section, 4,400 ft. at 7 cents per ft.

Aug. 9. From Saw Mill Creek towards Erie R. R., 1,480 ft. at 7 cents per ft.
Belleville Pike near Arlington, 8,789 ft. at 7 cents per ft.
Near P. R. R., Secaucus, 3,800 ft. at 7 cents per ft.

Oct. 25. Kearny stump-lots near D., L. & W. R. R., 6,000 ft. at 7 cents per ft.

Nov. 1. Kearny stump-lots north of Belleville Turnpike, 4,500 ft. at 7 cents per ft.
Cleaning and recutting 400 ft. of same territory at 10 cents per ft.

The Commission reports as follows on the prevalence of mosquitoes:

"Briefly stated, the conditions were by no means discouraging, considering the weather and other conditions which we had to contend with. Mosquitoes were not at all troublesome in any part of the county until well along in July. In Arlington, where they were found in greater numbers than in any other part of the county, they did not appear until about July 12, and were not troublesome after August 15; in fact, by that date had almost entirely disappeared. In Harrison and East Newark, the adjourning communities, they were not troublesome at any time during the season.

"At Snake Hill they were not noticed until about July 20, and were troublesome there only about four weeks. Bayonne was not afflicted seriously until about August 1, and then the trouble existed only along the shore front, principally on the east and south sections of the city and along Newark Bay. Lafayette, Hoboken, West Hoboken and Union Hill experienced far less trouble than in previous years. In North Hudson, adjourning the Bergen County line, *pipiens* were found troublesome as early as July 1. In Jersey City, particularly along the western section from Newark Avenue to the Bayonne line and west of Summit Avenue and the Boulevard,

salt-marsh mosquitoes were considerably troublesome subsequent to July 20, for about three weeks. Jersey City, east of Summit Avenue from Lafayette to Hoboken, was practically free of mosquitoes during the entire season.

"Considering the conditions found in reference to the mosquito pest throughout the state, we think we have reason to feel pleased with the scarcity of the mosquito pest in this county and the short duration of their period of annoyance. We find but a few who complain of being annoyed indoors, and the use of bed canopies for protector purposes is a thing of the past.

"Among the communicable diseases reported throughout the county, we find only two cases of malaria reported to the Kearny Board of Health, both of which appeared after the patients had returned from a vacation in the country."

Bergen County

The mosquito commission started this year with the definite plan of devoting a large proportion of the labor budget to upland drainage and retaining for the salt-marsh work merely enough properly to maintain the work already done. The commission's idea in making this plan was to test the efficiency of the drainage system already established on the salt marsh. On the whole, salt marsh as judged by the breeding found seemed to be pretty well drained. It appeared that the North Arlington meadow would be more easily controlled if some cross ditching were placed to secure a better circulation by breaking the long diagonal ditches, some of which are nearly one mile in length. It appeared that the Lyndhurst meadow drainage would be greatly improved by the constructing of a modern automatic tide-gate in Stump Creek. It seemed that the widening of certain sewage-charged ditches in the East Rutherford meadow would be advisable. Walden's and Leive's woodlands, the first lying south and the second north of the Paterson Plank Road, must be drained. The Overpeck Creek meadow should be drained.

Plans for the efficient carrying out of the work just mentioned are being worked out.

The commission feels that its work on the upland has involved the completion of a number of pieces of drainage work that are of a real importance to the communities where the work occurred. The policy followed in carrying out this work has been to secure the

financial cooperation of the community in which the work was to be done. In this way many miles of drainage have been installed and many of the worst breeding spots in the county have been eliminated.

In this way extensive pieces of drainage were done at West Moonachie, Hasbrouck Heights, Ramsey, Fort Lee, Oradell, Rutherford, Palisade Township, Haworth, Englewood, East Paterson, Riverside, Teaneck, Westwood, Emerson and Camp Merritt.

Most of the ditching is of the open or uncovered type and the effect of the frost is bound to be felt in the sliding in of the banks and the formation of obstruction which must be removed from time to time.

Table 5

Record of Mosquito Collections in Bergen County

Date	Number of stations	Total number of mosquitoes caught					Total	Average number of mosquito per station	Number of minutes spent at each station	Average length of time required to catch 1 mosquito per station
		Salt-marsh	Fresh-water swamp	Woodland pool	House mosquito	Others				minutes
6/8, 1917....	7	4	4	2	3	0	13	1.6	20	12.5
6/19, 1917...	29	19	29	14	8	0	70	2.4	20	8.0
6/26, 1917...	36	8	23	4	8	1	44	1.2	20	16.6
7/3, 1917....	43	21	95	7	33	..	156	3.7	20	5.4
7/10, 1917...	25	5	15	5	26	2	53	2.3	20	8.5
7/17, 1917...	19	4	29	..	40	..	73	3.8	20	5.3
7/24, 1917...	42	71	121	6	28	..	226	5.3	20	3.7
8/1, 1917....	40	24	133	4	27	..	188	4.7	20	4.3
8/8, 1917....	43	17	60	1	35	..	113	2.6	20	7.6
8/14, 1917...	40	47	83	7	49	3	189	3.4	20	5.8
8/21, 1917...	29	40	10	3	41	4	98	3.3	20	6.0
8/28, 1917...	42	18	27	..	27	2	74	1.7	20	11.0
9/14, 1917...	35	2	4	..	12	..	18	.5	..	40.4
9/11, 1917...	9	0	0	0	0	0	0	..	..	..

For the purpose of giving some notion of the prevalence of mosquitoes, table 5, based upon the regular weekly night collections, is introduced. In interpreting it one must remember that these collections are made in weed patches and in shrubbery where the mosquitoes are much more abundant than in the open streets, roadways, and yards.

Note: Salt-marsh species include *A. cantator*, *A. sollicitans*, and *A. taeniorhynchus*.
Fresh-water swamp species include *M. perturbans* and *A. sylvestris*, mostly the latter.
Woodland pool species include *A. subcantans* and *A. canadensis*.
House mosquito *C. pipiens*.
Other species *A. punctipennis* and *A. quadrimaculatus*.

The dominance of the fresh-water swamp mosquito is strikingly shown in the column entitled "Total number of mosquitoes caught." There were evidently three main issues from the salt marshes—the first reaching its highest point abount June 19, the second about July 3 and the third, the largest of all, about July 24. The fresh-water swamp brooks follow the same plan, but became relatively more abundant in the late midsummer issue.

Passaic County

In Passaic County the work of mosquito control was limited to the cities of Paterson and Passaic, Aquacknock Township, and the boroughs of Hawthorne, Prospect Park, Totowa, and West Park. This territory amounts to 75 square miles and has a population of 241,000, or 91 per cent of the entire population of the county. The funds were too small to make it practicable to include the whole county.

In the absence of salt marshes the entire attention was given to the suppression of fresh-water species.

At regular intervals throughout the mosquito-breeding season, all parts of the territory were examined and all breeding discovered eliminated in so far as possible. Owing to lack of funds most of the elimination work was of a temporary character.

Breeding in 223 swamps and reasonably permanent pools, 1,220 barrels and tubs, 1,690 cisterns and wells, 648 sewer catch basins and 116 cesspools and drains was revealed by the inspection work.

The Passaic River from Dundee Dam to Wagaraw Bridge, a distance of about five miles, became at times, along the banks and the shores of the sludge islands, an intense breeder of mosquitoes. Patrol by means of a boat and elimination by covering the breeding surface with oil was necessary throughout the summer. Along that part of the river from the Dundee Dam south to the Ackerman Avenue Bridge, a number of isolated pools proved to be virulent breeders and had to be regularly treated with oil.

An effort to invoke the authority of the mosquito section of general health laws was made with little success. Only two boards of health responded in a way to get any real results.

For the purpose of giving an idea of the prevalence of mosquitoes throughout the cities of Paterson and Passaic during the present season, table 6, based upon regular collections, is presented. It must be remembered that the collections here recorded were made

in weed patches or shrubbery where the mosquitoes are much more abundant than in the open street or dooryard.

Taule 6

Record of Mosquito Collections in Passaic County

Date	Number of stations	Total number of mosquitoes caught: Salt-marsh	Fresh-water swamp	Woodland pool	*House mosquito*	*Others*	Total	Average number of mosquito per station,	Number of minutes spent at each station	Average length of time required to catch 1 mosquito per station
										minutes
21, 1917...	48	22	105	2	1	..	130	2.7	20	7.4
27, 1917...	48	33	114	..	6	..	153	33.0	20	6.0
5, 1917....	48	20	23	..	..	..	43	0.8	20	25.0
11, 1917...	51	1	9	..	7	..	17	0.3	20	66.0
19, 1917...	57	5	22	2	7	..	36	0.6	20	33.0
26, 1917...	51	17	147	17	17	..	181	3.5	20	5.7
2, 1917....	51	9	71	4	8	1	93	1.8	20	11.0
9, 1917....	51	5	68	3	15	1	92	1.8	20	11.0
16, 1917...	48	10	14	..	14	..	38	0.7	20	28.0
23, 1917...	54	3	18	..	27	1	49	0.9	20	22.0

ote: Salt-marsh species include **A. cantator, A. sollicitans,** and **A. taeniorhynchus.**
Fresh-water swamp species include **M. perturbans** and **A. sylvestris**, mostly the latter.
Woodland pool species include **A. subcantaus** and **A. canadensis**.
House mosquito **C. pipieus.**
Other species **A. punctipinnis** and **A. quadrimaculatus.**

It is obvious that early in June there was an outbreak of the fresh-water swamp mosquito, and that a similar emergence occurred during the latter part of July.

Judging by the expression of public opinion as reflected in the newspapers the mosquito pest was this year greatly reduced.

Essex County

The mosquito control work in Essex this year as in previous seasons has been county-wide. Throughout the mosquito-breeding season at regular intervals all parts of the county were carefully examined for mosquito breeding. Whenever any was found it was as completely destroyed as the conditions would permit.

Without doubt the inspection and elimination work of this county were more intensive than those of any other county. More men were

ESSEX·COUNTY·MOSQUITO·EXTERMINATION·COMMISSION

UPLAND REPORT—STATISTICS SEASON OF 1917.

DAY		VATS, BBLS & TUBS		CISTERNS		CESSPOOLS		MANURE PITS		CELLARS		STREET GUTTERS		SEWER BASINS		BROOKS, DITCHES & DRAINS		PONDS & POOLS		SWAMPS		MISCELLANEOUS			
		NUMBER OF NEW ITEMS FOUND	NUMBER OF ITEMS FOUND BREEDING	do	do	do	do	do	do	do	do	do	do	do	do	do	do	do	do	do	do	do	do	NUMBER OF YARD INSPECTIONS	
Dist	1	3068	2438	35	28	8	8	25	34	39	45	28	85	2187	13122	71	103	102	248	50	137	76	184	189771	
"	2	483	564	56	60	11	7	115	27	65	75	80	37	2442	12210	103	124	171	268	5	11	106	161	137441	
"	3	219	845	12	30	4	11	16	32	6	11	4	10	130	520	46	136	71	123	47	110	111	359	72684	
"	4	54	271	18	23			6	2	19	80	74	41	1731	5193	64	46	53	88	18	23	15	123	63470	
"	5	45	843	12	1	9	10	1	6	4				25	50	46	90	29	215	35	74	37	216	25058	
"	6	100	600	280	560	400	1200	40	15			58	174	74	370	50	50	350	1750	52	208	37	185	1535	
"	7	247	1519	84	336	38	152	183	12	51	63	15	1	225	900	171	301	826	1141	76	200	247	1417	46560	
	8	54	162	35	105	92	276	1								12	36	36	108	34	102	10	30	2300	
	xx																								
Total	xx	4860	6342	532	1143	568	1664	327	128	184	214	199	288	6814	32365	563	886	1638	3955	317	865	638	2665	538819	

FIG. 4.—Statistics of Mosquito work in Essex County.

employed, more oil was spread and more money was spent. The tremendous amount of inspection done and the large number of breeding places found are shown in figure 4.

On the salt marsh only such work as was necessary to prevent industrial development from destroying drainage was undertaken. Owing to the absence of killifish in the ditches behind the dikes, there was much mosquito breeding in them. This had to be killed by oiling, but as is usually the case not all the breeding could be caught by this means. The establishment of a circulatory system by means of which the drainage systems are more or less flushed and supplied with a abundance of fish is necessary to eliminate this breeding in the ditches which always follows shutting off an area from penetration by fish.

Table 7

Record of Mosquito Collections in Essex County

Date	Number of stations	Total number of mosquitoes caught						Average number of mosquitoes per station	Number of minutes spent at each station	Average length of time required to catch 1 mosquito per station
		Salt-marsh	Fresh-water swamp	Woodland pool	House mosquito	Others	Total			minutes
/20, 1917...	35	14	92	13	3	..	136	3.8	20	5.2
/27, 1917...	43	27	150	12	3	..	192	4.4	20	4.5
/5, 1917....	56	38	84	9	6	..	137	2.4	20	8.3
/11, 1917...	64	10	22	11	16	..	59	0.9	20	22.0
/18, 1917...	60	51	49	8	18	..	126	2.1	20	9.4
/25, 1917...	67	72	163	11	70	..	316	4.7	20	4.2
/1, 1917....	78	75	304	5	34	..	418	5.3	20	3.9
/8, 1917....	74	47	82	3	49	1	182	2.4	20	8.3
/15, 1917...	59	28	63	..	74	2	167	2.8	20	7.1
/22, 1917...	78	13	33	2	45	..	93	1.1	20	18.0
/29, 1917...	75	5	16	2	32	..	55	0.7	20	28.0
/5, 1917....	76	1	...	..	8	1	10	0.1	20	200.0

Note: Salt-marsh species include **A. cantator, A. sollicitans,** and **A. taeniorhynchus.**
Fresh-water swamp species include **M. perturbans** and **A. sylvestris,** mostly the latter.
Woodland pool species include **A. subcantans** and **A. canadensis.**
House mosquito **C. pipiens.**
Other species **A. punctipennis** and **A. quadrimaculatus.**

For the purpose of giving a notion of the prevalence of mosquitoes during the past season, table 7, based upon regular collections, is submitted. It should be remembered in interpreting this table that the collections were made in weed patches and shrubbery where the mosquitoes were much more abundant than in streets and open dooryards.

A consideration of the table shows that about June 27 there was a noticeable outbreak, principally of the fresh-water swamp mosquito, and that a similar thing occurred the latter part of July and the first part of August.

Union County

In Union County the mosquito control work was of county-wide character and consisted of the regular examinations of the entire territory of the county for breeding followed by its destruction in so far as the conditions would permit whenever found, and in the accomplishment of as much permanent elimination work through drainage as the funds rendered possible.

Approximately 250,000 linear feet of ditching obstructed with mud or sod was cleaned early in the season.

The enclosure of that portion of the North Elizabeth meadow, which lies just east of the Central Railroad of New Jersey by tide-gating the creek and principal ditches and closing up the rest was completed, and 1,300 acres were thereby protected from flooding by high tide.

The need for a more efficient method of cleaning out the large outlet ditches and creeks led to the purchase of a small dredge carrying a 9-cubic foot orange-peel bucket. It was used to clean out Great Ditch on which the drainage of all the south end of the western section of the North Elizabeth meadow depends. This machine which cut a channel 5 feet deep and 13 feet wide removed 12,080 cubic yards of mud at a cost of 13 cents a cubic yard, and cleaned the ditch for a distance of 6,035 linear feet.

An area of about 40 acres on the Linden meadow lying just back of the Grasselli Chemical Plant became a virulent breeder. The Company not only furnished a large gang of men for temporary work but contributed the sum of $500 toward the installation of a tide-gate in Pylis Creek, which when taken with a tide-gated sluice-way to be introduced by the Central Railroad Company through the Sound Shore Railway just south of the chemical plant, will shut the high tides off of about 235 acres, including this 40-acre spot.

To the systems already present, 57,941 linear feet of 10x30-inch trenching was added, making a grand total on the 4,000 acres of 974,260 feet of ditch, 1½ miles of dike and 18 sluices and tide gates.

The drainage of pools and swamps has gone forward this year, about 100 being treated. Since the beginning of the work approximately 1,900 such places have been eliminated through the drainage by cooperation between the mosquito commission and the owners.

For the purpose of giving an idea of the prevalence of mosquitoes, table 8, based on the night collections, is submitted. In interpreting this table one must remember that the collections were made in weed patches and shrubbery where mosquitoes are more abundant than in the open streets, roadways, and open yards.

Table 8

Record of Mosquito Collections in Union County

Date	Number of stations	Total number of mosquitoes caught						Number of minutes *mosquitoes per station* Average number of	Average length of time spent at each station	mosquito per station, required to catch 1
		Salt-marsh	Fresh-water swamp	Woodland pool	House mosquito	Others	Total			minutes
6/6-7, 1917..	28	4	3	3	..	..	6	0.2	20	100.0
6/12-13, 1917	27	19	28	..	14	..	61	2.2	20	9.0
6/19-20, 1917	33	22	117	6	9	1	156	4.6	20	4.3
6/27, 1917...	33	15	144	1	11	1	172	5.2	20	3.8
7/5, 1917....	36	26	97	8	18	1	150	4.0	20	5.0
7/12, 1917...	33	2	18	..	16	1	37	1.1	20	18.0
7/18-19, 1917	33	56	45	..	7	..	108	3.2	20	6.2
7/25-26, 1917	33	54	126	2	21	3	206	6.2	20	3.2
8/1-2, 1917..	30	28	124	4	10	5	171	5.7	20	3.5
8/8-9, 1917..	30	38	56	..	36	..	130	4.3	20	4.6

Note: Salt-marsh species include **A. cantator, A. sollicitans,** and **A. taeniorhynchus.**
Fresh-water swamp species include **M. perturbans** and **A. sylvestris,** mostly the latter
Woodland pool species include **A. subcantans** and **A. canadensis.**
House mosquito **C. pipiens.**
Other species **A. punctipennis** and **A. quadrimaculatus.**

It is evident that there was an outbreak about the middle of June reaching its climax about June 27, and that the fresh-water swamp mosquito was mostly to blame.

A second outbreak came about July 25, in which both the salt-marsh and fresh-water swamp species were concerned.

Middlesex County

In Middlesex County the mosquito commission has continued its work of (1) keeping the present drainage systems in operation;

(2) examining the entire salt marsh at regular intervals throughout the mosquito-breeding season; (3) using oil to destroy such breeding as the drainage systems failed to kill; (4) cutting as much additional ditching as the funds would permit; (5) furnishing expert oversight and management for locally-supported campaigns against fresh-water mosquitoes.

In the early spring sod and mud blockage was removed from all the drainage systems throughout the county. As the examinations exhibited the need of further attention of this sort it was given. Upon the superintendent fell the duty of carrying out the regular salt-marsh examinations. When breeding was found in sections where the drainage would remove enough of it to render the use of oil practicable, oil was applied and the residual breeding destroyed.

Table 9 will show the drainage established in previous years and the amount which it has this year been able to add.

Table 9

Salt-Marsh Drainage in Middlesex County, 1914-1917

Meadow	Acres	Linear Feet of Ditches Cut					
		Previous to 1914	Cut During				Total
			1914	1915	1916	1917	
Carteret	578	61,700	5,000	9,349	500	1,765	78,314
Sewaren	447	56,600	1,000	10,965	2,100	757	71,412
Woodbridge Creek	711	30,000	......	17,319	1,500	1,150	22,688
Raritan	2,235	105,600	32,000	68,000	171,050	66,677	443,327
Sayreville	332	3,000	......	......	......	......	3,000
South Amboy	204	18,000	17,000	7,245	11,250	945	54,439
Cheesequake	1,600	144,000	......	760	......	3,140	157,900
Marquis Creek	86	4,000	......	379	......	1,200	5,579
Whale Creek	77	6,000	......	936	......	......	6,936
	6,270	438,900	55,000	114,943	186,400	75,634	843,596

During this season for the first time industrial development of the salt marshes has interfered with the progress of mosquito work. The principal interference has come from the effluent discharged from gun-cotton factories. The effluent contains from 1 to 3 per cent of acid, composed of both sulfuric and nitric acid. At that strength mosquitoes can not breed in it, but when diluted with marsh water it becomes a medium in which they will breed. Unfortunately, the killifish upon which the success of the drainage system depends is more sensitive to acid than the mosquito wriggler. Acid-charged water areas may become heavily charged with breeding and not a single killifish will penetrate them. The situation demands a

prompt remedy, but thus far nothing really practicable has been found.

Another sample of industrial interference occurred at Carteret on the Rahway River meadow. Here the Mexican Petroleum Corporation, in the course of filling a large area along the Arthur Kill, filled up one of the main outlets of the marsh and transformed what was formerly a reasonably well-drained salt marsh into a virulent breeder of salt-marsh mosquitoes. This corporation, when once it understood the situation, financed the construction of a 6-foot ditch to serve as a new outlet.

With the exception of an undrained section on the upper course of the Cheesequake Creek, the acid-soaked section near the Nixon Nitration Works near Millville, and the shut-off section of the Carteret meadow, the breeding of salt-marsh mosquitoes was well controlled. Broods from the first furnished bad mosquito trouble to the village of Cheesequake, Parlin and parts of South River. Two broods—one in July and one in August—from the second made trouble in Metuchen, Highland Park and Stelton. Broods from the third troubled Carteret. Woodbridge, Sewaren, Perth Amboy, the main portion of South Amboy and Morgan were scarcely at all troubled.

Monmouth County

In Monmouth almost the entire attention of the mosquito commission is centered on the salt-marsh of 3,315 acres. The only exception is the maintenance of fresh-water work in the Rumson and Little Silver district.

All parts of the salt marshes were examined at regular intervals throughout the mosquito-breeding seasons. Wherever mosquito breeding was found additional drainage was established. The distribution and the amount of ditching follows:

	Linear Feet
Belford	8,931
Port Monmouth	3,000
Keansburg	440
Union	16,253
Oyster Creek	441
Matawan	2,555
Whale Creek	582
Rumson and Little Silver	5,200
Manasquan	9,074
Total	46,476

In the fresh-water mosquito work in the Rumson and Little Silver district the entire area was carefully examined at regular intervals and the breeding destroyed whenever found. During the season, of the 375 places found breeding, 350 were temporarily eliminated and 300 were later permanently abated. These 375 places consisted of 70 cesspools, 15 catch basins, 5 row boats, 1 roof gutter, 1 cellar, 1 pond, 50 barrels, 150 tin cans and 82 pools and marshy places.

The fresh-water breeding in the vicinity of Camp Vail of the Signal Corps Unit located at Oceanport was kept under control, the men working in cooperation with camp sanitary corps.

Relative to prevalence of mosquitoes in Monmouth, the superintendent of the work reports as follows:

"The result of the season's work was not as satisfactory as had been hoped for during the first part of the season, but with constant and extra efforts on the part of the entire working force at hand the remaining part of the season proved to be successful and kept up to standard."

Ocean County

As in previous years the mosquito commission has devoted its attention primarily to the salt marsh; paying little attention to the regular examination of the drained areas and giving almost its entire effort to the cutting of new drainage.

At the beginning of the season, the sod, weed and worst mud blockages were removed from the entire system and all ditches put into operation.

During the year a total of 538,277 linear feet have been arranged for, nearly all or quite all of which have been cut. The bulk of this work has been done in the south end of the county, relieving almost 5,000 acres from serious mosquito breeding. Moreover, the small depressions in this area are being filled with sod taken from the ditches.

Concerning the prevalence of mosquitoes the commission reports as follows:

"The summer of 1917 has been a severe test of the faith of those who are not conversant with the habits of mosquitoes and the work done for their control.

"*When there is a combination of heavy rains and high tides it* taxes any system of meadow drainage, however perfect, to carry off the water within 8 days, or the time it takes from hatching to adult.

"There were three of these combinations this summer, one of *which caused a brood that got off July 15 and this was followed* by another August 20. Another emerged September 20.

"The meadows have been examined frequently by our superintendent, and breeding conditions noted, and we know that such *mosquitoes as reached the adult stage on the drained areas of Ocean* County, or the part north of Manahawkin, were comparatively few and would not have been commented upon had it not been for the terrible flights from the undrained salt marshes. The spots on *the drained meadows from which* the mosquitoes came are known and will come in for an early treatment in 1918. Some have already been corrected."

Atlantic County

While Atlantic County has devoted the greater part of her attention to the suppression of salt-marsh mosquitoes she has made a successful effort to combat the fresh-water species that breed within the limits of her towns and cities. All the drained salt marshes and all territory covered by the towns and cities are regularly examined throughout the mosquito-breeding season and such breeding as is found is eliminated in so far as possible. In addition to this work as large a part of the undrained salt marsh as the funds will permit is selected and drained.

Previous to 1917, 4,355,138 feet of mosquito ditching had been cut on the salt marsh. The cost of labor necessary to put this system in good operation at the outset of the present season amounted to $1,857.72. During the season of 1917, 992,735 feet have been added at a cost of $12,668.12 making a total of 5,347,873 linear feet of mosquito ditching on the salt marshes of the county. With the exception of Brigantine, the salt marsh of Atlantic is now drained from Leed's Point to Somer's Point, along the north shore of the Egg Harbor River, and work is now going on between Egg Harbor and Middle Rivers.

Very few mosquitoes escaped from the drained marshes, but the enormous broods produced on the undrained marshes of Atlantic

and her immediate neighbors flooded the county at times with a severe pest of mosquitoes. The June brood covered the Shore Road and reached Egg Harbor and Hammonton. Fortunately, it scattered quickly and lasted only a short time. The July brood from the undrained areas was very large. Egg Harbor and Hammonton probably had more mosquitoes than at any time since the work began. May's Landing was severely infested. The Shore Road was troubled. The August brood came off the undrained marshes in a scattering fashion.

Although some mosquitoes were present in Longport, Margate and Ventor and about the inlet, Atlantic City got no mosquitoes until the twenty-fifth of August when a northwest wind brought in a supply which reached the board-walk in several places. They quickly disappeared and the city was not troubled during the rest of the season.

Cape May County

The plan adopted last year by the mosquito commission of devoting practically all the funds at its disposal to salt-marsh drainage work and of beginning the work at the south end of the county and working northward has been continued this year. It is the plan which will give noticeable protection in the shortest space of time because the warm, moist, slow-moving winds on which mosquitoes love to travel normally come from the southeast, south, southwest and west. As the marshes are drained mosquitoes which formerly bred there and were carried by the wind to the towns lying to the east, northeast, north and northwest will not come, and the towns will be relieved. Only rarely will the mosquitoes which breed to the northwest, north and northeast be carried in.

As the towns and cities are relieved from the salt-marsh species the house mosquito becomes troublesome; not because of greater abundance but because the removal of the greater pest affords people an opportunity to take note of the lesser.

The ditching necessary in the Cape Island Creek meadows, the Spicer Creek Marsh, the meadows along the sound from Schellenger's Landing east to Jones' Creek near Wildwood road, the meadows of Pond Creek, New England Creek, and Cox Hall Creek, has been completed. This means that all the salt marsh from the

southern end of the Cape May Point to Jones' meadows along the Delaware Bay shore, a distance of about 7 miles, and all the salt marsh along the Atlantic Ocean side from the Cape May Point to Turtle Gut Inlet, a distance of 8 miles, has had the necessary initial trenching installed. This has involved the cutting in 1916-17 of 533,702 linear feet.

The shifting sand of the Bay shore has compelled the installation of a special tide-gated outlet for Pond Creek, and it now seems likely that similar outlets will for the same reason have to be provided for both New England and Cox Hall Creeks.

The South Cape May marsh lies so low and has such an inadequate outlet through Cape Island Creek that the installation of a tide-gate to prevent overflow at extra high tides seems advisable.

The city and boroughs in the vicinity of which this work has been done, have shown a commendable spirit of cooperation. Cape May City, through its board of health, has ditched all ponds and low lands within its limits. It has regularly oiled its culverts and catch basins throughout this mosquito-breeding season. The boroughs of West Cape May, Cape May Point and South Cape May ditched the worst spots within their limits. The city of Wildwood, acting under the advice of the commission, did a considerable amount of draining and oiling.

It is reported that Cape May City had mosquitoes for only three days this season, and that they were not severe at these times. It is reported that the borough of West Cape May, Cape May Point, and South Cape May experienced great relief. It is also stated that the city of Wildwood realized a considerable amount of protection.

Mercer County

The mosquito-control work in Mercer County differs from that in all the preceding counties in that it is located at one point only (Princeton and vicinity), and is concerned primarily with the reduction of the malaria-carrying species. In last year's report an account of the survey and progress of the work was set forth. The following description prepared by Dr. Ulric Dahlgren, the chairman of the unofficial mosquito extermination committee and the most active agent in the matter, will serve to show the nature of the work and its results.

"We do not know whether our malaria was a new-world disease or was brought to this country by settlers from the old world. As there are several kinds of malaria in most localities, it seems probable that at least some of our varieties were brought over by the first or some of the early emigrants. These different kinds depend on the different species of protozoan parasites that produce them. The parasites get into our blood and, multiplying vastly, they bore into and break up vast numbers of the red blood cells, producing the well-known chills and fevers and other symptoms that so many are familiar with.

"How do they get into our blood? One way only is known. A mosquito bites us and first she injects some fluid into our tissues to make the blood flow readily, and then she sucks out as much of this blood as she needs. If she stings a person with malaria she sucks out some of these parasites with that blood, and if she subsequently stings normal persons she injects some of the parasites into their blood and then they get the disease.

"The affair is not as simple as the above paragraph would make it seem, however, or else we would all have malaria most of the time. It must be a particular kind of mosquito, the *Anopheles* mosquito of one or more species that does the transferring, and, furthermore, the biting of the sick person must precede the infection of the new victim by a certain period. Still, if there are enough of these mosquitoes and enough sick people around to infect them, nearly all people will eventually get the trouble.

"These particular *Anopheles*, or malaria-bearing mosquitoes, are found only in certain kinds of stagnant or slow-moving waters. And one of the localities in which they have been found in New Jersey from the earliest settlers' records, is the lowland south of and next to Princeton, N. J. About the worst spot was one known as 'The Basin,' about a half-mile south of the edge of the town. Here, in the last century, the Delaware and Raritan Canal has been built through, and at this point several (four) large basins had been constructed to allow the canal boats to pass in and out of the line of traffic to unload at their leisure. A customs house, the station of the Camden and Amboy Railroad from New York to Philadelphia (now removed), as well as hotels, dwellings, warehouses and other buildings were erected, and the surrounding grounds were cared for, a certain amount of grass kept cut, and the waters were

so stirred and used by passing boats that they were not very good for the breeding of mosquitoes.

"The advance of civilization with its various engineering features and changes of physical surroundings always favors some forms of wild life and is against the welfare of others. On the other hand, the recession of man from a civilized and occupied area again changes the conditions so that some of the forms of natural life have their state of prosperity altered. In the case of the Princeton Basin we find a mixed condition from the start. The cutting of steep banks and sides, the elimination of wild grasses and weeds by constant use, probably worked against the *Anopheles* mosquitoes, while it permitted the multiplication of the common but harmless nuisance, the household mosquito of civilization. If the town had grown up around the basin the menace to health by *Anopheles* would probably have been eliminated, but matters never went that far, however. On the outskirts of the little settlement the dump heaps from excavation and the building of embankments formed pools and marshes and dammed up waters, on the edges of which grass and weeds overhung the bank, and here *Anopheles* probably held its own. At any rate, we hear of malaria in the region which had its ups and downs, rising at times to the strength of epidemics, of some of which the elder inhabitants of the town have a distinct recollection. At one time it was so bad that the people of Princeton seriously considered moving all houses and permanent residents from the basin. The college authorities were much worried at times over the matter.

"A time came finally, about fifty years ago, when for many reasons the 'Basin' became neglected and fell into disuse. The railroad was moved to a better grade and roadbed nearly two miles south, and the branch built to connect it with Princeton came up to the town and did not connect with the basin. Also the railroad bought the canal, and nearly all the freight and coal that had been carried on the canal was now brought directly to the town on the cars. As a result the 'Basin' lost many of its inhabitants, and the various buildings fell into disrepair and most of them into ruin. Banks caved in, drains were obstructed, trees grew and flourished around the basins, and, worst of all, grass and weeds overhung the banks to form the quiet natural retreats so favorable to the malarial pest.

"The study of the situation was carried on by the following measures: first, a survey by experts representing the State Board of

Health, the State Agricultural Experiment Station and the local entomologists, to determine where the mosquitoes bred. All breeding mosquitoes were located by the larvæ being present in the waters examined, but the dangerous *Anopheles quadrimaculatus* Say was found only in outlying streams and pools, mostly in the waters of the 'Basin' and the extensions of these waters in the lowlands east on the line of the Delaware and Raritan Canal. Such pools and marshes as showed these larvæ or 'wrigglers' were carefully marked down on the map as solid black circles. Secondly, a study of the mosquitoes on the wing was inaugurated. Nine men went out just after sunset twice a week for the whole summer and stood for half an hour with bared forearm and a bottle to catch such mosquitoes as attempted to bite them. They then moved to a second station and spent another half hour as bait and ended the evening with a similar period at a third station. These twenty-seven stations covered the town and surrounding country in such a way as to show how far the different kinds of mosquitoes flew and how thick they were. Here was shown the fact that the malarial mosquito was not the most abundant form and was a poor flier from his birthplace. But there were enough, and they wandered in diminishing numbers up into the town from the 'Basin' and its eastward extending chain of pools and other waters.

"In the third place, a medical survey was made and all cases of malaria were placed on the map as one-line circles. The town was pretty well peppered with these, but the 'Basin' was riddled with cases. Almost every house had some cases, in some every member. One family of eight all had it. These victims were able to get around. Some could work, while others could not, and a few were perfectly healthy. The new cases suffered most acutely.

"An engineer next made a careful survey of the entire region which menaced the town, and in collaboration with Dr. Headlee, of the State Agricultural Experiment Station, planned the most economical and efficient way of treating each pool, swamp, or other body of water in order to make it impossible for *Anopheles* to breed there. Small bodies of water were marked to be filled, some large bodies to be drained in whole or in part, followed by filling. Some waters that could not be eliminated were to have their banks cut and trimmed. No temporary measures were suggested

"Armed with the knowledge thus acquired the Princeton Committee then cast about for means to put their ideas into deeds. It was decided that the town, or rather some of its beneficent members and institutions, would be able and willing to contribute some $5,000 or over, and after promises were obtained the Princeton Committee went to the Mercer County Mosquito Commission to enlist their aid in getting the Board of Freeholders of Mercer County to appropriate $5,000 to carry the thing through. After consulting the director of the Experiment Station at New Brunswick as to the feasibility of the plan, the commission asked the freeeholders and they appropriated the money, and the work was begun under the supervision of an engineer, Mr. C. S. Sincerbeaux.

"This work is at present only partly done. And yet a large and important part of it is finished. The worst pools around the basin have been eliminated, and other large bodies have been filled or drained. The committee must still collect money to push the work to completion.

"Certain larger property holders in the region have attended to the difficulties in their own portions of the district. The Walker-Gordon Farm, St. Joseph's College, and the Rockefeller Institute have done or are doing thorough work based on the survey. This work has extended only over one summer, and yet good results have been shown already, although the committee hardly dared hope for them at so early a period.

"Briefly these results are about as follows: In 1914, 127 cases of malaria were reported to the Princeton Board of Health; in 1915, 65 cases were reported; in 1916, 8 cases were reported.

"A study of these figues has led the commission to believe that the fall in cases from 127 in 1914 to 65 in 1915 was due to two factors: first, more careful diagnosis by the town phpsicians, who began using a blood test before reporting any chills and fever as malaria, and second, to a very efficient cleaning up of the town and warning to the people of the danger, with methods of avoiding it.

"Nineteen hundred and sixteen, however, was a fine mosquito year, with its wet weather and favorable temperatures for mosquito breeding, and the very large and satisfactory drop seems to be caused by only one factor—the engineering work carried to partial completion during that summer."

Mosquitoes of the Year

The first brood of salt-marsh mosquitoes, which usually appears during the first half of May, came out in small numbers along the lower Atlantic and the Bay coasts, and was scarcely noticeable in northern New Jersey.

The second brood appeared about the middle of June in the south and about 5 or 6 days later in the north. In the south this brood was large enough to migrate 25 miles or more back into the pines.

The third brood began to come out about the tenth of July in Cape Map County, appeared in Atlantic about the twelfth and made itself felt in the north about the sixteenth. This brood was large from the undrained salt marshes and carried far. Indeed the number escaping from the drained marshes was unusually large.

The fourth brood emerged during about the corresponding period of August. It was not so large as the preceding, nor did it travel so far.

The fifth brood began emerging from the tenth of September in the south to the sixteenth in the north. Although not so general as was the August brood, in limited areas the density was great and the annoyance serious.

The first, or May, brood was composed of *A. cantator* with a few *A. sollicitans* along the Delaware Bay Coast. The second or June brood consisted of *A. cantator* in the north and *A. sollicitans* in the extreme south, with a mixture of the two species between. The third or July brood consisted of *A. cantator* and *A. sollicitans* in the north and *A. sollicitans* throughout the southern two-thirds of the coast. The fourth and fifth broods were mostly *A. sollicitans,* although *A. cantator* appeared from the upper courses of the streams when bordered by salt marsh.

In June and again in July the fresh-water swamp mosquito appeared in large numbers, especially in July. Taking the season as a whole this species (*A. sylvestris*) has been the dominant mosquito in point of numbers, throughout the non-sandy section of the sea-coast.

For the purpose of giving a notion of the prevalence of mosquitoes during the very worst portion of the season the following series of collections made July 27 and 28 is appended (table 10). All collections were made in shrubbery in broad daylight. All collec-

tions were the work of two collection bottles. When the total catch in 5 minutes reached 30, the limiting factor became the length of time necessary for the bottles to kill.

Table 10

Mosquitoes Collected July 27 and 28, 1917

Name of place	County	Number of mosquitoes				
		Salt marsh	Fresh-water swamp	Woodland pool	Malarial	House mosquito
Stelton	Middlesex	0	1	1	0	0
Plainfield	Union	0	2	4	0	0
Fanwood	Union	1	1	3	0	0
Springfield	Union	0	1	1	0	0
Essex Park (south end)	Essex	0	0	3	0	0
Essex Park (north end)	Essex	0	0	0	0	0
North Arlington Cemetery	Hudson	7	9	0	0	1
Weequahic Park	Essex	4	7	0	0	0
Elizabeth	Union	2	4	4	0	0
Woodbridge	Middlesex	1	4	0	0	0
Just northwest of Morgan	Middlesex	12	0	0	0	0
Shrewberry River (north branch)	Monmouth	1	0	0	0	0
Manasquan	*Monmouth*	*2*	*0*	*0*	*0*	*0*
Bay Head	Ocean	5	0	0	0	0
Osbornville	Ocean	2	0	0	0	0
Beachwood	*Ocean*	*2*	*0*	*0*	*0*	*0*
Forked River	Ocean	16	0	0	0	0
Barnegat	Ocean	25	0	0	0	0
Tuckerton	*Ocean*	*30*	*0*	*0*	*0*	*0*
Port Republic	Atlantic	15	0	0	0	0
Woodbine	Cape May	30	0	0	0	0
Cape May City	Cape May	3	0	0	0	0

The collection at North Arlington Cemetery was made at the edge of bad breeding marsh. The collection near Morgan was made near a piece of undrained salt marsh. In Ocean County the mosquitoes from the large undrained areas to the south were met in increasing numbers from Forked River as we went south until the full density of the brood was reached at Tuckerton. Port Republic was like the rest of the Shore Road, beside drained marshes but in reach of flights from undrained meadows. At Woodbine the full density of the brood was found. The marshes in the neighborhood of Cape May City are drained and the mosquitoes must come in on a northeast or a northwest beeeze.

The table strikingly illustrates the absence of the fresh-water swamp and woodland pool problems from that portion of the coast which lies south of the Raritan River.

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*
WILLIAM H. MARTIN, M.SC., *Research Assistant.*
*WEBSTER S. KROUT, M.SC., *Research Assistant.*
†ROBERT F. POOLE, B.SC., *Research Assistant.*

*Resigned April 1, 1917.
†Appointed May 1, 1917.

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Report of the Department of Plant Pathology

MELVILLE THURSTON COOK, PH.D.

ORGANIZATION

The organization of the department has undergone a considerable change since our last report. Mr. W. H. Martin, M.Sc., continues with us as assistant. Mr. W. S. Krout, M.Sc., resigned April 15 to accept a position as assistant plant pathologist in the Massachusetts Agricultural Experiment Station. His place was filled by Mr. R. F. Poole, B.Sc., of Clemson College, South Carolina, who assumed his duties on May 1. Mr. C. M. Haenseler, M.Sc., who held the Fellowship established by the New Jersey Zinc Company for the study of fungi injurious to plants, was called to the Colors September 8. Mr. C. A. Schwarze continues as assistant state plant pathologist employed by the New Jersey State Department of Agriculture.

INVESTIGATIONS

The special investigations for the year have been as follows:

1. The study of diseased potato seed for the purpose of determining the influence of certain diseases on the yield. This work has been carried on for the past three years: in 1915 and 1916 by the writer assisted by Dr. H. C. Lint, and in 1917 by the writer assisted by Mr. Haenseler and Mr. Poole. A discussion of the results obtained is appended to this report.

2. A study on spraying potatoes for the control of diseases. This is a continuation of the work conducted by Dr. H. C. Lint in 1915 and 1916. The work was on the farms of Mr. J. Harry Kandle, Elmer, N. J., and Mr. T. M. Appleby, Dayton, N. J. Mr. Irving L. Owen, County Demonstrator for Middlesex County, gave most hearty cooperation in the work on Mr. Appleby's farm. A discussion of this work is appended to this report.

3. The spraying of tomatoes for the control of plant diseases. This work was in cooperation with the Bureau of Plant Industry, of the United States Department of Agriculture and the Campbell Soup Company. The work was conducted on the Campbell Soup Company Farm at Moorestown, N. J., and was under the immediate direction of Mr. W. H. Martin assisted by Mr. D. H. Davenport. A discussion of this work is appended to this report.

4. A study of fungi injurious to paints by Mr. C. M. Haenseler. Good progress was made with this problem but the work was not carried far enough to justify the publication of a report at this time.

5. A study of the diseases of celery by Mr. R. F. Poole. This work was conducted on the farm of Tunis Drenth, Oradell, N. J. A discussion is appended to this report.

6. We also started a number of minor problems which it may be necessary for us to discontinue for want of necessary assistants.

EPIDEMICS

There were no very pronounced epidemics in 1917 although there was considerable loss due to plant diseases. In the early part of the season the conditions were exceptionally good for plant production, but heavy rains about the middle of July were followed by a great many complaints. In the early part of the season the potato crop was exceptionally free from injurious diseases, but immediately following the heavy rains there was an unusual amount of tip burn, which was followed with an exceptionally large amount of early blight. The result was a loss ranging from 25 to 40 per cent in different parts of the state. In this connection it is worth noting that the loss was, as a rule, less on the crops where carefully selected or certified seed was used than on those grown from the market run of seed. It is also worthy of note that the loss was less on crops on good soils and on those which were well fertilized than on poor soil and on land where a small amount of fertilizer was used.

The department also received complaints concerning an unsatisfactory condition of peppers growing in the vicinity of Newfield. An investigation showed that on many farms the plants were small and frequently with poor root systems. In many cases there was a tendency to drop the foliage and blossoms. A careful

investigation failed to reveal any organism or soil condition to which this could be attributed. This is a problem which should receive careful attention another year.

We received a great many complaints concerning the scalding of maple leaves. This was no doubt due to physiological conditions.

We also received a great many reports of a bacterial disease of corn. This is apparently the same disease that was originally described by Prof. Burrill of Illinois in 1889. It has been observed by Dr. B. D. Halsted and others in New Jersey for several years, but was somewhat more severe this year than in the past.

PLANT DISEASE SURVEY

The war conditions have emphasized the importance of both a national and a state plant disease survey. These surveys should indicate the relative importance of disease in various parts of the state and nation. They should be made by trained plant pathologists who have an appreciation of the agricultural interests of the state. They should be of such character as to facilitate the research work of the agricultural experiment stations, also the demonstration work of the extension division.

NEEDS

In addition of the need of a careful and thorough plant disease survey which should be continued from year to year, we are in need of work on the following problems.

1. A study of the diseases of the potato.
2. A study of the diseases of the tomato.
3. A study of the diseases of legumes.
4. A study of the diseases of grains.
5. Studies on the many diseases of truck crops.
6. Studies on the many diseases of ornamental crops.

THE HERBARIUM

Unfortunately the herbarium has been neglected for many years. The mounted plants should be gone over carefully and put in place. Several hundred unmounted plants should be mounted and carefully distributed so that they can be used. This work should be [illegible] in connection with the plant disease survey.

PUBLICATIONS

The following publications have been issued during the past year:

Circular 68. Common Diseases of Cucumbers and Melons.
William H. Martin.

Circular 71. Diseases of Tomatoes.
Mel. T. Cook and William H. Martin.

Circular 75. Spray Calendar for Apples and Quinces.
" 76. Spray Calendar for Pears.
" 77. Spray Calendar for Sweet Cherry.
" 78. Spray Calendar for Plum.
" 79. Spray Calendar for Peach.
T. J. Headlee, Mel. T. Cook and M. A. Blake.

Circular 80. Common Diseases of Apples, Pears and Quinces.
" 81. Common Diseases of Peach, Plum and Cherry.
" 84. Common Diseases of Beans and Peas.
Mel. T. Cook.

INSPECTION

The inspection work which is under the direction of the New Jersey State Department of Agriculture has been reorganized and Mr. H. B. Weiss appointed chief inspector with general supervision over the details of the inspection work for both insects and plant diseases.

During the spring and summer we were assisted in scouting for the blister rust of the white pine by two special inspectors sent to us by the United States Bureau of Plant Industry. The disease was not found in any of the blocks of stock which were placed under quarantine in 1916, but was found in one other block of stock, which has also been placed under quarantine. One of the scouts also found a considerable amount of wild *Ribes* (alternate host) in Sussex County but fortunately the disease has not made its appearance in that locality.

This disease has been the subject of numerous quarantines by the United States Department of Agriculture and by a number of states during the past year. The character of this disease and the strenuous efforts of the Federal Government and the various states to eradicate it justify us in continuing our quarantines on the blocks of white pines in which the disease has been found.

MOST COMMON DISEASES OF THE YEAR

The following is a list of the diseases collected by members of this and other departments and sent in by the growers.

Alfalfa

LEAF SPOT (*Pseudopeziza medicaginis* [Lib.] Sacc.). This disease continues with about equal severity from year to year. It is probably correlated with quality of seed but may also be correlated with soil conditions.

WHITE SPOT (Cause undetermined). Prevalent but not serious. We also find a similar spotting on the clovers.

LEAF SPOTS (*Pleospora* sp., *Cercospora medicaginis* E. E. and *Stagnospora carpathica* Baulm). Occasional.

Several undetermined leaf spots which may have been incipient stages of some of the above, or due to some other causes, were sent in from time to time.

Ampelopsis

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was quite common on the lower part of the ivy plants on buildings, and was a very serious pest in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidata.*

DIE BACK (*Cladosporium* sp.). This disease occurs on the *A. tricuspidata.* It was much less severe than in 1915.

Apple

JONATHAN SPOT (*Alternaria* sp.) A peculiar spotting of the Jonathan is without doubt due to this organism. It continues to be equally severe from year to year.

Other very similar spots are no doubt due to other causes. The study of these minor apple spot rots is of greater importance than is at first apparent. They no doubt serve as points of infection for other and more serious rot organisms. The minor spot rots in their relation to the more serious rots should be the subject of a very careful and thorough study.

BLOSSOM END ROT (*Alternaria* sp.). This disease continues to cause more or less trouble with many varieties. It is frequently associated with black rot.

ANTHRACNOSE OR BITTER ROT (*Glomerella rufomaculans* [Berk.] S. & Von S.). A few records. It is of very little importance in orchards that are properly sprayed.

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards. It frequently appears as a blossom end rot but should not be confused with the *Alternaria* blossom end rot.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni). This disease was less destructive than in 1916.

BLOTCH (*Phyllosticta solitaria* E. & E.) This disease has been very severe on some varieties, especially Smith's Cider, but no more severe than in previous years.

SOOTY BLOTCH (*Phyllachora pomigena* [Schw.] Sacc.). Common in unsprayed orchards.

SCAB (*Venturia pomi* [Mont. & Fr.] Sacc.). This disease was prevalent throughout the state, but did not reach the proportion of an epidemic.

BROWN ROT (*Sclerotinia fructigena* [Per] Schr.). Occasional.

PINK ROT (*Cephalothecium roseum* Cda.). Common.

LEAF SPOTS (*Phyllosticta pyrina* Sacc. and *Sphaeropsis malorum* Pk.). Common and about as severe as usual.

RUST (*Gymnosporangium juniperi-virginianae* Schw.). Very common in Cape May County and frequently collected in small quantities in other parts of the state. (*G. globosum*). Occasional.

CROWN GALL (*Pseudomonas tumefaciens* E. F. Smith and Townsend). This very common disease is receiving more attention from nurserymen and growers. We have had several reports concerning it.

WATER CORE. Occasional.

SPRAY INJURY. Occasional.

WINTER INJURY. More or less common throughout the state.

Asparagus

RUST (*Puccinia asparagi* De C.). Occasionally, but not in sufficient quantity to be of importance.

Aster

YELLOWS. This disease, which is due to an unknown cause, occurred in many places and was very destructive. We have had a smaller number of complaints than usual.

Barley

SMUT (*Ustillago nuda* [Jens.] Kell & Sw.). Very common and in some cases very abundant.

POWDERY MILDEW (*Erysiphe graminis* D. C.). Occasional.

Beans

ANTHRACNOSE (*Colletotrichum lindemuthianum* [Sacc. & Magn.] Bri. & Cav.). This disease was more or less common but was not the cause of many complaints

LEAF SPOT (*Phyllosticta phaseolina* Sacc.). This disease was quite common on the leaves of lima beans.

POD SPOT (*Phoma subcircinata* E. & E.). This disease was quite common on the leaves of lima beans.

DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Occasional.

ROOT ROT (*Rhizoctonia* sp.) This organism is frequently present in cankers on the stems. It was frequently associated with *C. lindemuthianum*.

RUST (*Uromyces appendiculatus* [Pers.] Lev.). Occasional.

BACTERIAL BLIGHT (*Pseudomonas phaseoli* E. F. Smith). This disease was quite prevalent in the early part of the season on the seedlings and was very destructive. It was less destructive later in the season.

POOR FRUITING (Cause unknown). We had several inquiries concerning the setting of pods which did not produce seeds. This was apparently due to lack of pollination.

Beet

LEAF BLIGHT (*Cercospora beticola* Sacc.). Quite common.

ROOT ROT (*Phoma betae* Frank). This rot has been found in a few cases in both fields and storage.

Blackberry

ANTHRACNOSE (*Gloesporium venetum* Speg.). Common and destructive in many places.

LEAF SPOT (*Septoria rubi* West.). Common.

RUST (*Gymnoconia peckiana* [Howe] Tranz.). Common.

Cabbage, Cauliflower and Kohlrabi

CLUB ROOT (*Plasmodiophora brassicae* Wor.). The reports indicate that this disease was more prevalent than usual.

BLACK ROT (*Pseudomonas campestris* [Pammel] Smith). Reported frequently, and in most cases very destructive.

DAMPING OFF (*Rhizoctonia* and *Fusarium*). Several reports.

YELLOWS (*Fusarium conglutinans* Wollenw.). Common and sometimes destructive.

Cantaloupe

See Muskmelon.

Carnation

RUST (*Uromyces caryophyllinus* [Schrank] Wint.). Common but not serious.

ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.

YELLOWS (?). Serious on some varieties.

Carrot

LEAF BLIGHT (*Macrosporium carotae* E. & L.). Only one report but in that case very severe. Unverified reports indicate that the disease was prevalent and severe in other parts of the state.

Catalpa

LEAF SPOT (*Phyllosticta catalpae* Ell. & Mart.). Common. Note: This leaf disease was accompanied by a falling of the leaves which many people supposed to be due to the disease. The spotting was no more severe this year than in previous years, and the falling was probably due in part to ather causes.

LEAF SPOT (*Cercospora catalpae* Wint.). Common.

Cedar

RUST (*Gymnosporangium juniperi-virginianae* Schw.) (*Gymonosporangium germinale* Schw. [Kern]). Reported, but of little importance. The former was most abundant in Cape May County.

Celery

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Reported from several places. Very destructive.

LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.). Very abundant in certain localities. Most important celery disease in the

HEART ROT (Bacterial ?). Very severe in many localities.

STEM ROT (*Sclerotinia libertiana* Fckl.). Very severe in one locality.

Cherry

BROWN ROT (*Sclerotinia cinerea* [Pers.] Schr.). Common.

LEAF SPOT (*Cylindrosporium padi* Karst.). Common.

WINTER INJURY. Several complaints.

Chestnut

BARK DISEASE (*Endothia parasitica* [Mur.] Ander.). Common throughout the state.

LEAF SPOT (*Actinopelte japonica* and *Marssonia ochroleuca* B. & C.). Frequent.

Chrysanthemum

WILT (*Fusarium* sp. or *Verticillium* sp.). Common on certain varieties in greenhouses.

DODDER (*Cuscuta* sp.). In one greenhouse.

Corn

SMUT (*Ustilago zeae* [Beckm.] Ung.). This very common and widely distributed disease is not often serious except on sweet corn.

WILT (*Pseudomonas stewarti* Erw. Smith). Very few reports.

BLIGHT (*Bacterium* sp.). Common. (See page 525.)

RUST (*Puccinia sorghii* Schw.). Not serious.

LEAF BLOTCH (*Helminthosporium inconspicuum* E. & E.). Common. Farmers attribute this to weather.

Cowpea

LEAF SPOT (*Cercospora dolichii* E. & E.). Frequent.

Cranberry

SCALD (*Guignardia vaccinii* Shear.). This disease was widely distributed throughout the state, and the cause of considerable loss where the bogs were not well sprayed.

Cucumber

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. [Smith]). Very widely distributed and the cause of considerable loss.

DOWNY MILDEW (*Plasmopara cubensis* [B. & C.] Humphrey). Common and frequently the cause of heavy losses.

LEAF SPOT (*Macrosporium cucumerinum* E. & E.). Frequent.

STEM ROT (*Sclerotinia libertiana* Fckl.). Occasional. Very destructive in one greenhouse.

Currants

CANE BLIGHT (*Botryosphaeria ribis* G. & D.). Frequent.

LEAF SPOT (*Septoria ribis*). Very common.

Dahlia

LEAF SPOT (*Phyllosticta* sp.). Common.

ROOT ROT (*Sporotrichum* sp.). One report.

Dewberry

DOUBLE BLOSSOM (*Fusarium rubi* Wint.). This disease continues with equal severity where the nurserymen and growers do not try to control it. However, many of our most progressive men are keeping it well under control by hand-picking the diseased buds early in the season. It is most severe on Lucretias, Rathbuns and Black Diamonds.

ANTHRACNOSE (*Gloesporium venetum* Speg.). Very abundant and in some cases destructive.

LEAF SPOT (*Septoria rubi* West.). Common.

RUST (*Gymoconia peckiana* [Howe] Tranz.). Reported as common and in some cases destructive.

Eggplant

LEAF AND STEM BLIGHT AND FRUIT ROT (*Phomopsis vexans* [Sacc. & Syd.] Harter). Very common and in some cases destructive.

WILT (*Fusarium* sp.). Common and destructive.

Gladiolus

ROOT ROT (*Rhizoctonia* sp.). Occasional.

Gooseberry

ANTHRACNOSE (*Pseudopeziza ribis* Kleb.). *Gloesporium* stage has been found in several places.

LEAF SPOT (*Septoria ribis* Desm.). Common.

Grape

BLACK ROT (*Guignardia bidwellii* [Ell.] Viala & Ravaz). Common and very destructive in many vineyards in the southern part of the state.

ANTHRACNOSE OR BIRD'S EYE ROT (*Gloesporium ampelophagum* Sacc.). Occasional.

RIPE ROT (*Gloesporium fructigenum* Berk.). Occasional.

NECROSIS (*Fusicoccum viticolum* Reddick). Occasional.

DOWNY MILDEW (*Plasmopara viticola* [B. & C.] D. T.). Common but not serious.

BITTER ROT (*Melanconium fuligineum* S. & V.). Occasional.

Hollyhock

RUST (*Puccinia malvacearum* Mont.). Very common and the subject of many inquiries.

Horse Chestnut

LEAF BLOTCH (*Phyllosticta paviae* Desm.). Less severe than usual.

Lettuce

DROP (*Sclerotinia libertiana* Fckl.). Common.

Lilac

MILDEW *Microsphaera alni* [Wallr.] Wint.). Abundant throughout the state.

LEAF SPOT (*Phyllosticta halstedii* Ell.). Reported from several localities.

Maple

TAR SPOT (*Rhytisma acerinum* [P.] Fr.). Occasional.

LEAF SPOT (*Phyllosticta acericola* C. & E.). Common.

ANTHRACNOSE (*Gloesporium apocryptum* E. & E.). Several records.

LEAF SCALD (Physiological). Many complaints.

WINTER INJURY. Occasional.

Muskmelon

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. Smith). Common and destructive in some cases.

DOWNY MILDEW (*Plasmopara cubensis* [B. & C.] Humphrey). Common but not severe.

MOLD (*Cladosporium cucumerinum* Ell. & Arth.). Common.

Oak

ANTHRACNOSE (*Gnomonia veneta* [Sacc. & Speg.] Kelb.). The *Gloeosporium* stage was sent in a few times.

MILDEW. Conidial stage.

Oats

SMUT (*Ustilago avenae* [Pers.] Jens.). Common.

RUST (*Puccinia coronata* Cda.). Common.

RUST (*Puccinia triticina* Eriks.). Common.

RUST (*Puccinia graminis* Pers.). Occasional.

Okra

WILT (*Verticillum* sp.). Abundant in one locality.

Onion

BULB ROT (*Botrytis* sp.). One report, not serious.

Pea

LEAF SPOT (*Ascochyta pisi* Lib.). Occasional.

Peach

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.). Common throughout the state. Severe on fruit in unsprayed orchards.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Towns.). Common. See apple.

LEAF CURL (*Exoascus deformans* [Berk.] Fuckel). Abundant where the orchards were not sprayed.

SCAB (*Cladosporium carpophilum* Thum.). The severity of this very common disease varied with the thoroughness of the spraying.

SHOT HOLE (*Phyllosticta circumscissa* Cooke). Common.

SHOT HOLE (*Bacterium pruni* Smith.) Common and in some cases very severe.

POWDERY MILDEW (*Sphaerotheca pannosa* [Wallr.] Lev.). Occasional.

YELLOWS AND LITTLE PEACH. Much more severe than usual, frequently causing heavy losses in well kept orchards which previously were comparatively free from disease.

WINTER INJURY. Several reports.

Pear

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni.). Common. See apple.

LEAF BLIGHT (*Fabrea maculata* [Lev.]). *Entomosporium* stage. Abundant on leaves and fruit. This disease is likely to cause severe losses in good crop years unless the growers give more attention to its control.

LEAF SPOT (*Septoria pyricola* Desm.). Abundant.

BROWN BLOTCH (Cause undetermined). Abundant.

Peony

BUD ROT (*Botrytis* sp. ?). Prevalent.

Pepper

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common in fall.

ROT (*Macrosporium* sp.). Common on fruits. May have been secondary.

MOSAIC (Cause undetermined). Very severe and the cause of heavy losses.

SUN-BURN. The fruits of the large fruited varieties are frequently sun-burned, making them very susceptible to rot injuries.

Pine

BLISTER RUST (*Cronartium ribicola* Fisch de Waldh.). This disease was found in one nursery.

Poplar

LEAF SPOT (*Marsonia populi* [Lib.] Sacc.). Common.

CANKER (*Dothichiza populae* S. & B.). Common and destructive wherever established.

Potato

SCURF (*Rhizoctonia* or *Corticium vagum* D. & C. var. *solani* Burt.). This is a very widely distributed disease, but was less severe than in previous years.

BLACK LEG (*Bacillus phytophthorus* Appel). This well known disease was less severe than usual.

SCAB (*Actinomyces chromogenus* Gast.). This disease was fully as severe as in past years.

EARLY BLIGHT (*Alternaria solani* [E. & M.] S. & G.). This disease was very abundant and very destructive immediately following the heavy rains about the middle of July. It was closely associated with tip burn.

LATE BLIGHT (*Phytophthora infestans* De By.). This disease was not reported, but probably occurred in the mountainous districts.

TIP BURN. Very abundant and very destructive immediately following the heavy rains about the middle of July.

LEAF ROLL (Cause unknown). Less severe than usual.

CURLY DWARF (Cause unknown). Uncommon.

Phlox

POWDERY MILDEW (*Erysiphe communis* [Wahl.] Schl.). Common.

Privet

ANTHRACNOSE (*Gloesporium cingulatum* [Atk.] S. & S.). Occasional.

Plum

BLACK KNOT (*Plowrightia morbosa* [Schw.] Thüm.). Common throughout the state.

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.). Common throughout the state.

SHOT HOLE (*Phyllosticta circumcissa*). Occasional.

LITTLE PLUM (Cause undetermined). Occasional.

Quince

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and very severe. See apple.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni). See apple.

RUST (*Rostellia aurentiana* Peck.). Occasional.

Raspberry

ANTHRACNOSE (*Gloesporium venetum* Speg.). Abundant and destructive.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Towns.). Abundant. See apple.

LEAF SPOT (*Septoria rubi* West.). Abundant.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Very abundant and destructive. The cause of many complaints.

Rose

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Towns.). Frequent.

ANTHRACNOSE (*Gloeosporium rosae* Hals.). Common but not serious.

LEAF BLOTCH (*Actinonema rosae* [Lib.] Fr.). Common and very severe in the greenhouse.

POWDERY MILDEW (*Sphaerotheca pannosa* [Wallr.] Lev.). Common and very severe.

LEAF SPOT (*Phyllosticta rosicola Massal.*). *Abundant and frequently* confused with black spot.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common.

Snapdragon

ANTHRACNOSE (*Colletotrichum anthirrhini* Stew.). Occasional.

RUST (*Puccinia anthirrhini* D. & H.). Occasional.

STEM ROT (*Sclerotium*). One record. Very destructive.

Squash

MOSAIC (Cause undetermined). One record. A peculiar mottling of the leaves, characteristic of the disease on other plants. No insects present.

Strawberry

LEAF SPOT (*Mycosphaerella fragariae* [Tul.] Lindau.). Common.

LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.

LEAF SPOT (*Marsonia potentillae* [Desm.] Fisk). Frequent.

WINTER INJURY. Frequent.

Sunflower

RUST (*Puccinia helianthii* Schw.). Occasional.

Sweet Potato

BLACK ROT (*Sphaeronema fimbriatum* [E. & H.] Sacc.). Abundant and very severe.

WET ROT (*Rhizopus nigricans* Ehr.). Common in storage but readily controlled by ventilation.

STEM ROT OR YELLOW ROT (*Fusarium batatatis* Wollen.). Common and very destructive.

ROT (*Trichoderma Koenigii* Oud.). Frequent.

CHARCOAL ROT (*Sclerotium bataticola* Taub.). Frequent.

ROT (*Trichoderma Koenigii* Oud.). Frequent.

ROT (*Penicillium* sp.). Common. May have been secondary.

SCURF OR SOIL STAIN (*Monilochaetes infuscans* E. & H.). Common.

Sycamore

ANTHRACNOSE (*Gnomonia veneta* [Sacc. & Speg.] Kleb.). Very abundant.

Tomatoes

ANTHRACNOSE (*Colletotrichum phomoides* [Sacc.] Chester). A few reports.

FRUIT ROT (*Macrosporium solani* E. & M.). Abundant.

STEM BLIGHT (*Fusarium lycopersici* Sacc.). Common and very severe in some localities.

BLOSSOM END ROT (Cause questionable). Common.

LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and very severe in some localities.

MOSAIC AND FILIFORM LEAF (Cause undetermined). Very common but much less severe than in 1915 and 1916.

LEAF SPOT (*Marsonia juglandis* [Lib.] Sacc.). Abundant.

YELLOWS (Cause undetermined). Two records.

Watermelon

ANTHRACNOSE (*Colletotrichum lagenarium* [Pase.] E. & H.). Abundant in the southern part of the state.

WILT (*Bacillus tracheiphilus* E. F. Smith). Common.

Wheat

RUST (*Puccinia coronata* Cda.). Common. (*Puccinia graminis* Pers.). Occasional. (*Puccinia rubigo-vera* deC. Wint.). Common. (*Puccinia triticina* Errh.). Common.

SMUT (*Tilletia foetens* [B. & C.] Trel.). Frequent. (*Tilletia tritica* [Bei.] Wint.). Abundant.

MOLD (*Cladosporium herbarum* [Pers.] Lk.). Abundant in places.

Willow

LEAF SPOT (*Gloeosporium salicis* West.). Common.

REPORT OF CELERY INVESTIGATION

R. F. Poole

Experimental work started on the farms of Tunis Drenth and Drenth Bros. has been continued. Other investigations have been carried on at Gunlah's Farm, near Ridgewood. The principal diseases found this year were the same as reported in previous years. The past season has been very favorable for the spreading and the developing of bacteria and fungi. These have caused considerable loss in some parts of the bogs. The crown rot (*Bacterium* sp.), damping off or stem rot, (*Sclerotinia libertiana*), root knot caused by nematodes, the early blight (*Cercospora apii*), and the late blight (*Septoria petroselini*, var. *apii*), are the diseases of most concern to the farmers. Damping off caused by *Rhizoctonia* gave some trouble in one greenhouse this past spring.

In soil sterilization it was our purpose to rid the greenhouse beds and diseased areas in the field of the crown rot organism (*Bacterium* sp.). Some form of sterilization must be used to control damping off, caused by *Sclerotinia libertiana*. Acids, bases, and salts of different strengths have been applied to diseased areas in the field. Lime, hydrochloric acid, and copper sulfate have shown slight control. A more thorough trial must be given these compounds before any definite conclusion will be reached. Steam sterilization will, when thoroughly applied, control the organism. The irregularity of the diseased areas and the resistant plants, which grow in these diseased areas, greatly conflict with accurate control data. The crown rot organism has spread to practically every farm in the bogs of North Jersey. The best solution of the problem now seems to be plant breeding. In all diseased areas a small percentage of vigorous-growing, Golden Self-Blanching plants will be found to be immune to the crown rot organism. Seed from these resistant plants should produce a very high percentage of immune plants. Several farmers in this state grow their own celery seed each year. From work done on selecting disease-free cotton and cabbage, this appears to be an equally good chance for selection and, at the same time, teaches the farmer methods of breeding for higher plants.

During April several complaints of root knot were reported on [illegible] The knots, caused by nematodes, were formed several [illegible] after the soil was sterilized with formaldehyde. The

benches were decaying very badly and they were without a doubt the source of reinfection. The bench showing the most knots was divided into halves; one half was well stirred and treated with 6-50 formaldehyde. It was then covered with sacks for one week. The sacks were removed at the end of a week's time; the soil stirred and allowed to air for one week. Two weeks after the formaldehyde was put on, the seed was sown in both treated and untreated soil. The nematodes produced root knots in the untreated soil. as was the case in the first crop. The plants on the untreated soil showed no signs of root knot, and were vigorous-growing plants.

The *Sclerotinia libertiana*, damping off or stem rot, will soon be one of the celery growers' most troublesome pests. This is the same fungus that causes lettuce drop. It did a great deal of damage to beans in the bogs also. About twenty-five heads of lettuce with *Sclerotia* and growing mycelium were placed in a box 2x3 feet and mixed with soil. Celery seed was sown in the box, and after the plants were several inches high, they were kept in a warm, shady place and watered constantly. Almost all of the plants died as they had done in the greenhouses of North Jersey.

Celery, lettuce and beans are the farmers' chief crops in this section. Their continued growth on the same land makes it hard to select soil free from *Sclerotia* for the greenhouse beds. The matting together of the mycelium to form a hard *Sclerotia* which remains in the soil indefinitely, is difficult to penetrate and kill with formaldehyde unless conditions which are favorable to germination or decay are brought about. If the fungus is watched closely, the diseased spots can be removed before spreading. A light layer of sand on the surface will control the disease. The mycelium does very little, if any, damage below the surface of the soil. It spreads rapidly over the surface attacking the plants near or just above the ground. This disease is encouraged by crowding, not enough sunlight reaching the plant stem, and by overwatering.

After considerable damage to the plants, the beds were divided into four sections. Section I was thinned; the diseased plants were removed and sodium nitrate was broadcasted at the rate of 250 pounds per acre and washed into the soil. Section II was not

thinned, but nitrate of soda was applied as in Section I. Section III was thinned; the diseased plants were removed and no sodium nitrate was added. Section IV received no treatment. At the end of two weeks' time, the celery in Section I had made considerable growth, and very few plants were dying. Section II grew as well as Section I. However, the plants were very thick and most were dying. Section III had very few dead plants. They were very small and sickly. Only a very few plants remained in Section IV, and they had died early.

Several hundred plants were taken from Section I and set from 4 to 7 inches apart in the field. No diseased plants were found after transplanting.

The crown rot disease caused by *Bacterium* sp. has practically made the growing of Golden Self-Blanching celery unprofitable throughout the muck-soil districts.

In order to find a control for this disease, we have used carbolic acid, cresol, hydrochloric acid, copper acetate, lime, formaldehyde, sulfur, liver of sulfur, carbon bisulfide, potassium bisulfide, copper sulfate, ferrous sulfate, corrosive sublimate, potassium hydroxide, sodium chloride and calcium chloride. The liquids were diluted, and some poured into shallow holes, drenching the soil. The solids were either dissolved and applied in liquid form or applied in solid form by broadcasting and mixing with soil. The irregularity of the disease has made collecting control data very uncertain.

If Golden Self-Blanching plants are set into the field soon after all danger of being killed by frost is over, they seem to resist the disease. A large majority of the late plants die in a few weeks after they are set in the field. A few areas in the bogs this year grew the finest kind of first-crop celery; but the second crop was a complete failure on the same land. Soil removed from the greenhouse should never be placed on land free from crown rot. In a few instances this organism has been carried from upland by carting out soil from diseased areas. Crates shipped from one farm to another seem to be the source of spreading the organisms over the country. A quarantine should be placed on all old crates before another crop of celery is grown.

The results of the chemical project on Drenth Bros. farm are given in table 1. Sodium hydroxide, bleaching powder and carbon bisulfide were applied on April 13; and formaldehyde on May 8. All

long and 15 feet wide. The plants were set in the field on June 15. During the growing season, four counts were made of the plants in each section at different times. The number of healthy, sick and dead plants in each case is given in the table. Plants were designated as healthy when found growing normally, and sick when showing lack of growth and a yellowing of the foliage. This table, while not showing any control, does give the death rate, and indicates that a few chemical compounds like hydrochloric acid (HCl) and lime ($CaCO_3$) show some prospects of control.

Table 1

Results of Experiment on Control of Celery Diseases

Sections	Compounds	Strengths	Plants 6-28	1st Count 7-10			2nd Count 7-25			3rd Count 8-7			4th Count 8-17		
				Healthy	Sick	Dead	Healthy	Sick	Dead	Healthy	Sick	Dead	Healthy	Sick	Dead
1	Hydrochloric acid	5	296	220	76	0	114	155	0	113	185	0	26	270	0
2	*Sodium hydroxide*	*10*	311	214	97	0	91	220	0	58	232	21	23	267	21
3	Bleaching powder	8	309	254	55	0	128	118	0	128	181	0	36	260	18
4	Potassium sulfide	2	297	185	112	0	37	226	34	19	122	156	16	47	234
5	Calcium carbonate	8 tons per acre	291	266	25	0	210	76	5	111	175	5	33	254	5
6	Copper sulfate	2 2-3	307	208	99	0	118	90	99	27	150	130	27	126	154
7	*Carbon bisulfide*	*20*	309	205	104	0	133	162	4	184	100	25	20	123	166
8	Check		295	116	179	0	21	201	73	21	53	221	15	39	241
9	Bichloride of mercury	1 1-3	296	123	173	0	20	185	91	15	114	165	19	66	221
10	Check		305	114	185	6	31	204	70	22	134	149	21	74	210
11	Sulfur	11 lbs.	305	101	202	2	19	196	90	21	102	182	24	22	259
12	Cresol	1 1-3	298	93	205	0	23	149	126	23	53	222	20	5	272
13	Zinc chloride	8 1-2 lbs.	288	116	172	0	57	224	7	21	155	112	21	91	176
14	Hydrochloric acid	9 pts.	304	218	86	0	98	204	2	30	272	2	30	266	8
15	Check		298	230	68	0	45	230	23	21	151	126	18	71	209
16	Formaldehyde	24 pts.	278	218	78	0	60	211	17	27	110	141	14	57	206

The early blight, *Cercospora apii,* appeared during the latter part of July. It spread rapidly to many areas by thrips and hoppers. It did considerable damage to second-crop celery. The late blight, *Septoria Petroselini apii,* was found about the middle of August. It did considerable damage to late celery. If spraying is started in the greenhouse when the plants are small and continued every ten days in the field with a thorough spray of 5-6-50 Bordeaux or with 10-50 Kil-Tone, the leaf spots will give no trouble.

The growers are fortunate in being able to grow all green varieties on the diseased lands. It is our purpose to develop a Golden Self-Blanching strain which will be immune to the crown rot organism, *Bacterium* sp., by breeding for disease-resistance. The problems are many, and they will require more study in the future.

TOMATO SPRAYING EXPERIMENTS AT RIVERTON, N. J.

William H. Martin

During the summer of 1917 tomato spraying experiments for the control of late blight (*Septoria lycopersici* Speg.) were conducted on the Joseph Campbell Company farms at Riverton, N. J. The work was done by the department of plant pathology of the New Jersey Agricultural Experiment Station in cooperation with the Office of the Cotton, Truck and Forage Crop Disease Investigations of the United States Department of Agriculture and the Joseph Campbell Company. The writer wishes to express his thanks to Mr. H. F. Hall of the latter company and to Mr. G. Johnson, manager of the farm, for the many courtesies shown him during the progress of the work.

The experiment was designed to test out, under field conditions, sprays developed by Mr. F. J. Pritchard and Mr. W. Blair Clark of the Bureau of Plant Industry. At the same time an effort was made to determine some of the important facts in the life history of the organism causing late blight, and also to determine, if possible, how the disease is disseminated and how it lives over winter. This report will be limited to a brief discussion of the spraying experiments; a complete presentation of the other data will follow at a future date.

The late blight of tomatoes has been the cause of serious losses throughout New Jersey for a number of years. Ten years ago a 15-ton crop of tomatoes was by no means uncommon, this year it is doubtful if the average yield will exceed 4 tons. These figures are based on the statement of the growers. The tomato crop is well adapted to New Jersey conditions, but at the present cost of labor and fertilizers a 4-ton crop grown for the cannery will not yield a profit. A large part of this decrease in yield can be traced directly to the presence of leaf blight.

This is a comparatively new pest, not being recorded in the United States until 1893, and it is only in recent years that it has become severe. Thus far all efforts to breed resistant plants or to grow resistant varieties have failed and therefore spraying is the only method that has been found to combat the disease. In sections of New Jersey a number of growers have sprayed with the stan-

dard Bordeaux mixture for the control of late blight, and in some instances a partial control followed, but more frequently little differences resulted. In the work conducted by this department at Salem, N. J., in 1916 very little control was secured, although there was an increase in yield. This lack of success cannot be said to be due entirely to the spray, as it is a recognized fact that success in spraying is largely a question of methods, and also the time of application is an important factor. Last season the writer was unable to be in the field throughout the summer, so that it is possible that the applications were not made at the most opportune time. In 1917 the work was directed from a field laboratory so that a better opportunity was given to observe the progress of the disease. In this way the applications were not made at stated intervals, but when it was thought they would accomplish most good.

Spray Mixtures Used

The failure of the standard Bordeaux mixture to control the blight in the past indicated the advisability of using some other spray mixture or a modification of the standard Bordeaux mixture in its place. During the past season the following mixtures were employed.

1. Standard Bordeaux mixture in the proportion of 4 pounds of copper sulfate, 4 pounds of lime to 50 gallons of water. This was prepared according to common practice.

2. Standard Bordeaux mixture with resin fish-oil soap. This was prepared exactly as the preceding except for the addition of 3 pounds of soap to each 47 gallons of the 4-4-50 mixture. The soap was added to the mixture after it had been run into the spray tank, in order to eliminate the excessive formation of suds.

3. Bordeaux mixture with diminished lime, and resin fish-oil soap, 4-2-3-50. In this mixture the amount of lime used was one-half that of the copper sulfate. As in the preceding mixture the soap was added in the spray tank.

4. Deka-copper sulfate mixture with resin fish-oil soap 2-0.4-3-50. This mixture was made up according to Pickering's copper sulfate and lime water formula C[1] with the addition of 3 pounds of soap

[1]Eleventh Report, Woburn Experimental Fruit Farm, 1910.

to each 4 gallons of the mixture. It was prepared by stirring 4 gallons, containing 2 pounds of the copper sulfate solution, into 40 gallons of saturated lime water. This was then made up to 47 gallons and 3 gallons of soap solution, containing 3 pounds of soap added.

5. Copper-soap mixture, 0.5-0-3-50. This was prepared by diluting ½ gallon, containing ½ pound of copper sulfate solution, to 47 gallons and adding 3 gallons of the soap.

To facilitate the preparation of the sprays, stock solutions were made up. The milk of lime stock solution was made up at the rate of 1 pound of lime to 1 gallon of water, the copper sulfate, ½ pound to 1 gallon; and the soap, 1 pound to 1 gallon. No difficulty was experienced in getting the soap into solution, but hot water is necessary to dissolve it properly. After once in solution it will not settle out.

No trouble was experienced in mixing any of these sprays. When soap was added it was found best to do so after the mixture of the other ingredients had been run into the tank. If the soap is added in the mixing tank and then run into the spray tank, serious difficulties will be encountered. In some cases, where there was excessive agitation, an abundant formation of suds made trouble, but it was soon found that very little agitation was necessary to keep the mixtures in suspension, and after this no difficulties were experienced.

The advantages of the addition of soap were plainly seen. Not only did it increase the spreading qualities of the spray to a marked extent, but it also greatly increased its adhesiveness. Instances were noted where, after a heavy rain, the standard Bordeaux mixture was washed from the leaves, while the plants sprayed with the Bordeaux-soap mixtures were still white with the spray. It is also believed that the presence of the soap increases the fungicidal value of the spray.

Spraying Machinery

At the same time that sprays were tested out, an attempt was made to determine the method of applying the spray that would give best control. For this work two types of spray machinery were used. The first was a gasoline power sprayer furnished by the Office of Cotton, Truck, and Forage Crop Disease Investigations. This outfit

was a 2-horse 2-wheel cart with a 100-gallon tank. It was equipped with two lines of hose, each 25 feet long, one from each side of the machine. Each hose was equipped with a 5-foot iron extension rod, each rod being fitted with an angle nozzle. Five rows can be sprayed on each side of the machine, so that including the row driven over, 11 rows can be sprayed at one trip through the field. For the first several applications a pressure of 150 to 175 pounds to the square inch was maintained, for subsequent sprayings this was increased to 200 to 225 pounds. This pressure gave a very fine mist and the upper leaf surfaces were well covered. It was found practically impossible to cover the lower leaf surfaces completely. This was especially true when the plants had attained full growth; they fell to the ground and it was impossible to reach the lower surface of any but the uppermost leaves. Then again, the field in which the experiment was conducted became overgrown with weeds so that for the last applications it was impossible to spray the under leaf-surface.

The other machine used was a well known traction sprayer. With this machine a pressure of 150 to 175 pounds to the square inch was maintained. For the first applications there were only two nozzles to a row but this was found to be unsatisfactory and a third one was added. Three rows were sprayed at a time and the nozzles were so adjusted that a uniform film was distributed on the majority of the leaves. An attempt was made to adjust the side nozzles so as to reach the under leaf-surface, but this was found to be practically impossible, so only a part of the leaves received any spray on the under-surface. It will be shown later, however, that very satisfactory control was secured by both of these machines, and it would therefore appear that it was not absolutely necessary that the under leaf-surface be covered with a film of the mixture. No statements to this effect can be made at this time; it is hoped, however, that future work will throw some light on this point.

With the power sprayer the sprays were applied at the rate of 250 gallons to the acre. This thoroughly covered the upper leaf-surfaces. With the traction sprayer 175 gallons to the acre were applied. For the first application the plants were sprayed once, but as the covering obtained did not seem sufficient to give best results, for subsequent applications each plot was sprayed twice, once each way. In most instances this gave an ideal film. It was noticed that

too high pressure was not desirable for some of the sprays, especially with the copper-soap mixture. With a pressure of 150 pounds a uniform film could be secured, while with very high pressure the spray very often collected in drops. This can no doubt be explained by the presence of the soap, as it was not found to be true when the standard Bordeaux mixture was used.

Plan of the Experiments

As previously stated, the purpose of this work was to ascertain if the late blight could be controlled by spraying. Three sets of experiments were conducted. In the first, no attempt was made to limit the number of applications; they were made at approximately 10-day intervals throughout the season. In the second experiment the plots were sprayed two and three times, respectively, the first application being made sometime after the disease had made its appearance. This experiment was conducted to determine if the blight could be held in check after it had once made its appearance and also with the expectation that the results would be of aid in planning another season's work. The third experiment was with late tomatoes, the purpose of this experiment being also to determine, if possible, the effect on the ripening of the crop. Very frequently in New Jersey the late varieties are killed by frost before the crop is picked. It was thought that spraying might hold the leaves and further delay the ripening of the fruit. Should this happen the advisability of spraying late tomatoes is questionable. Each of these experiments will be discussed in turn.

Field Tests

The field in which this experiment was conducted was in tomatoes in 1914, okra in 1915 and tomatoes in 1916. After the 1916 crop was removed the field was put in rye; this was plowed under in the spring and fertilizer applied at the rate of 500 pounds to the acre before the plants were set out. The fertilizer was made up of 500 pounds of tankage, 400 pounds of nitrate of soda and 2000 pounds of acid phosphate. Shortly after the plants were established they were side-dressed with 300 pounds of fertilizer to the acre and again on July 7 with 350 pounds to the acre. For these two applications the mixture was made up of 1200 pounds of tankage, 400 pounds of nitrate of soda and 400 pounds of acid phosphate.

The plants were of the Bonney Best variety, an early tomato very much in favor in this part of the state. They were set out May 15, only thrifty plants being used. The rows were made 6 feet apart with the plants 3 feet apart in the row. This was done to permit the use of the power sprayer, the tread of the machine making it impossible to employ the 5-foot row customary in this state. The field as laid out contained 24 plots, each 6 rows wide. or approximately one-half acre. Between each six rows a driveway was provided for by the omission of a row. This was done to facilitate spraying and the taking of records. The employment of plots of this size eliminated to a large extent the extensive use of check plots otherwise necessary to minimize differences in yield resulting from soil variation. The need of check plots is recognized, but in this work where the check plots were employed largely to show differences resulting from spray treatment, their extensive use was hardly warranted.

Due to irregularities in the field the plots were not all the same size. In plots 23 and 24 a tree shaded some of the plants and these were discarded in getting yields. In computing the yield on an acre basis the yield per plant for each plot was determined and from this the yield per acre was obtained. As all missing plants were taken into consideration this method gives the most accurate measure of the actual yield per acre. In taking yields a count was made of the number of baskets from each plot; the yield in pounds per plot as then calculated from the average weight of 1000 baskets. This method was considered to be more convenient than and approximately as accurate as attempting to weigh all the baskets in the field.

The 24 plots were divided into 4 series of 6 plots each. In each series there were 5 sprayed plots and 1 unsprayed plot. Two of these, Series A and A-1, were sprayed with the power sprayer while the remaining two, Series B and B-1, were sprayed with the traction sprayer. This gave two instances of spraying with each type of spray machine, and four instances of spraying with each spray treatment. The four series were so arranged that the two methods of applying the spray alternated.

The purpose of this experiment being to determine if late blight could be controlled by spraying, no effort was made to limit the

number of applications, but as many were made as was thought necessary to control the disease. The present plan is to continue this work another season to determine how few applications are necessary to control the disease, as well as the most opportune time to make them. This season applications were made on the following dates: July 5, 12, 19, and 30, August 9, 17, and 27, making seven in all. It will be noticed that the first application was not made until the plants had become well established in the field. In the past, seed-bed spraying has been generally advocated. While this cannot be set aside from the results of one year's work, at least the results secured would tend to indicate that this application, as well as the very early applications in the field, can well be omitted. Late blight has been reported from other states as occurring in the seed-bed, but the writer has never observed it in this state. This year the disease was first observed on July 13. It was fruiting at the time, however, so that infection must have taken place about July 1. This first infection did not spread over the field, but this is no indication of what might happen another season. The general observations are that blight does not appear in this section of the state until about the middle of July; in the northern part of the state it frequently occurs two weeks earlier. Since the disease is present on the leaf some two weeks before it is evident to the eye, it might be well to make the first application about June 25, and a week or two earlier in the northern counties. It is frequently found necessary to spray for insects soon after the plants are set in the field, and again about two weeks later. For these two applications it would be well to use a combined insecticide and fungicide, which would take care of any early infections of late blight.

In table 1 is given the arrangement of the plots as they occurred in the field. This table also gives the yield per acre for ripe and green fruit, as well as the total yield per acre. From the table it will be seen that the yields of plots receiving the same treatment but in different parts of the experimental field vary considerably. This, no doubt, can be traced to soil differences, and in an experiment extending over so great an area this cannot be prevented. By the use of large plots, however, and repeating a treatment and its check four times, the differences resulting from the averages will give a fairly accurate measure of the benefit derived from the treat-

ment in question. It will be noticed, also, that the yield of green fruit is considerably greater from the sprayed plots than from the unsprayed. This may be accounted for by the fact that the sprayed vines remained vigorous for a longer period than the unsprayed. This green fruit was not wholly a loss, as it is common practice in New Jersey to pick and cover it when a frost is expected. In this way a greater part of the fruit is ripened, and therefore it well may be included in the total yields.

Table 2

Arrangement of Plots and Yield Per Acre of the Tomato Spraying Experiments Conducted at Riverton, N. J.

Treatment	YIELD PER ACRE		
	Ripe Fruit	Green Fruit	Total Yield
	Pounds	Pounds	Pounds
4-4-3-50	10,914	1381	12,295
4-2-3-50	9,897	864	10,761
4-4-50	12,608	1018	13,626
2-0.4-3-50	12,778	1638	14,416
0.5-0-3-50	12,463	609	13,072
Check	11,107	139	11,246
4-4-3-50	12,947	1011	13,958
4-2-3-50	12,391	1769	14,160
4-4-50	15,198	1327	16,525
2-0.4-3-50	15,464	2313	17,771
0.5-0-3-50	13,697	2313	16,010
Check	12,363	292	12,658
4-2-3-50	14,036	3630	17,666
4-4-3-50	14,036	3969	18,005
4-4-50	14,592	2787	17,379
0.5-0-3-50	15,560	1742	17,302
2-0.4-3-50	14,301	1255	15,556
Check	13,043	221	13,264
4-2-3-50	15,512	3242	18,754
4-4-3-50	15,415	1841	17,256
4-4-50	15,599	1473	17,072
0.5-0-3-50	13,939	1870	15,804
2-0.4-3-50	11,083	980	12,063
Check	9,784	166	9,950

Before discussing the yields from the different treatments, the control obtained by the use of the different mixtures will be considered.

Blight was first observed in this field on July 13. The disease had made very little progress from the point of initial infection, when a number of extremely hot days checked its advance. During this period the lower leaves of most of the plants in the field

were killed. An examination of the field on August 1 showed very little blight present, the infected leaves, for the most part, being killed during the hot weather. At about this time there was a week of wet weather and the disease again made its appearance. A careful survey of the field was made on August 13 and an estimate made of the number of leaves infected. Of the check plots two showed 50 per cent infection while the other two showed as much as 80 per cent. Several of the sprayed plots showed infection, but in these it was not more than 1 per cent. As the season advanced the sprayed plots showed considerably more infection, but the differences between them and the unsprayed plots were just as marked.

The last spray application was made August 27 and on September 7 an examination of all the plots was made to determine the per cent of dead leaves. This estimate was made to include all dead leaves, whether present on the plant or missing. It was impossible to do this for every plant, so every tenth plant in the middle row of each plot was taken.

Table 3 gives the per cent of dead leaves for each plot, as well as the average for each treatment.

Table 3

Per Cent of Dead Leaves on Each Plot and the Average for Each Treatment

Treatment	Per Cent of Dead Leaves				
	Series A	Series B	Series A-1	Series B-1	Average for each treatment
4-2-3-50	47	50	34	39	42
4-4-3-50	39	58	36	46	45
4-4-50	57	60	54	52	56
2-0.4-3-50	56	66	58	58	60
0.5-0-2-50	52	55	60	44	53
* Check	95	94	96	96	95

To make these estimates a more accurate measure of the actual condition of the plants, separate readings were made on the same day by the writer and Mr. D. H. Davenport, the field assistant, and the percentages given in the table represent an average of these two readings.

At the time these observations were made and for several weeks previous, the unsprayed plants were stripped almost bare of any

leaves, only a few remaining at the tips of the branches. The stems also were heavily infested with the blight. On the date of the observations, the average number of dead leaves for the check plots was found to be 95 per cent, while for the poorest spray plot it was 60 per cent. The Bordeaux-soap plots gave the best control, with the 4-2-3-50 mixture, only 42 per cent of the leaves being dead. While there was a difference of only 18 per cent between the number of dead leaves on the best and that on the poorest sprayed plots, throughout the season the plots sprayed with the 4-2-3-50 mixture were uniformly better than the plots receiving the other treatments. Likewise, the plots sprayed with the Pickering mixture were poorer, throughout the season, than any of the others. The plots sprayed with the copper-soap mixture looked slightly better than those sprayed with the standard Bordeaux mixture, though neither was as good as the Bordeaux-soap plots.

Not all the leaves missing from a plant were lost through disease for, as has been previously stated, a number were lost during the hot weather in July. It is recognized that this is true for both the sprayed and the unsprayed plants, but the difference between the different treatments and between the sprayed and unsprayed plots was more pronounced than is indicated in the table. The photographs appended to this report will tend to illustrate this point more clearly (plate 6, fig. 1 and 2).

The fruit on the unsprayed plants was exposed to the sun and the greater part of the fruit set, ripened. On the sprayed plants the fruit was protected by the leaves until later in the season, no doubt accounting for the large amount of green fruit on these plots at the end of the season. In this connection it might be well to state that the fruit from the sprayed plants was of a much better quality than that from similar unsprayed plants. When a vine is stripped of all its leaves the ripening process is largely artificial, and as a consequence the fruit is of a poorer quality both as to color and flavor.

In table 4 the per cent of dead leaves, the average weight of green and ripe fruit per acre and the total yield per acre for each treatment are given. In the last column of the table is given for each treatment the increase in pounds of green and ripe fruit over the checks.

In this table the treatments are arranged in the order in which they controlled the blight. It will be seen that the treatment having the least dead leaves on September 7 gave the greatest amount of green fruit at the end of the season, and, disregarding the 2-0.4-3-50 mixture, the treatments with the greatest number of dead leaves gave the largest yield of ripe fruit. On the plots sprayed with the 4-4-50 mixture 60 per cent of the leaves were dead, while on the plots showing the best control only 42 per cent of the leaves were dead. On a basis of ripe fruit the 4-4-50 treatment out-yielded the other by 1738 pounds, while in green fruit the 4-2-3-50 treatment out-yielded the 4-4-50 by 725 pounds.

Table 4

Per Cent of Dead Leaves with Yield Per Acre for Each Treatment

Summary

Treatment	Per cent of dead leaves. Average of four plots	Green fruit pounds per acre. Average of four plots	Ripe fruit pounds per acre. Average of four plots	Total yield pounds per acre. Average of four plots	Increase over check; green and ripe fruit
4-2-3-50	42	2376	12,959	15,335	3554
4-4-3-50	45	2050	13,328	15,379	3598
0.5-0-3-50	53	1634	13,915	15,548	3767
4-4-50	56	1651	14,697	16,348	4567
2-0.4-3-50	60	1646	12,406	14,052	3171
Check	95	204	11,577	11,781	....

These results would tend to indicate that it is not desirable to hold all the leaves until the end of the season if all the fruit is to be ripened. In this state very little, if any, of the fruit set after September 1 will mature, and the energies of the vine should then be turned to ripening that which is relatively mature. While no definite statement can be made from the data at hand it would appear advisable to hold all the leaves possible until about the first of September, and after that only enough to protect the fruit.

While the 4-4-50 mixture did not give best control it gave the greatest increase in yield, 38 per cent over the check. The copper-soap mixture gave the next highest increase, though the difference in the yields from these plots and the Bordeaux-soap plots was only 1 per

cent, the former giving a 31 per cent increase over the check, while the latter gave a 30 per cent increase. The 2-0.4-3-50 treatment gave the poorest control, and at the same time the lowest increase, 26 per cent over the check plots. The nature of this spray makes its adoption impossible on an economic scale, so that it need not be discussed further. Eliminating this treatment there was a difference of only 8 per cent between the highest and lowest increases over the check plots.

These differences are based on the total yield. On the basis of ripe fruit the 4-4-50 treatment showed an increase of 27 per cent over the check plots, the 0.5-0-3-50 treatment 19 per cent, the 4-4-3-50, 15 per cent and the 4-2-3-50, 11 per cent. Here again is brought out the relation of the per cent of leaves held late in the season to the amount of fruit ripened. There is a variation of 16 per cent between the best and poorest treatments on the basis of ripe fruit, as compared with a difference of 8 per cent where total yield is considered.

While the copper-soap mixture did not give the best control, it is without doubt the most desirable of any of the mixtures used. Since it requires only ½ pound of copper sulfate and 3 pounds of soap to each 50 gallons of water, its use would mean a decided saving in the cost of materials over the old 4-4-50 mixture. The ease with which it is prepared and the fact that no lime is required are other factors very much in its favor. While it cannot be recommended from the results of one season's work to take the place of Bordeaux mixture, it is certainly worthy of future trial, and, should it prove as satisfactory as it has this year, there is little doubt that it will take the place of Bordeaux mixture for tomato spraying.

The Bordeaux-soap mixtures gave best control of the blight. This was even more noticeable than is indicated in the table showing the per cent of dead leaves. During the entire season the plots treated with these mixtures, and especially with the 4-2-3-50 mixture, stood out above all the others in vigor of the vines. There was little difference in yield between these and those treated with copper-soap mixture, however, so that what little difference there was in the control of the blight is amply made up for by the many advantages of the latter mixture.

Use of Traction and Power Sprayers

As has been stated, two of the four series, A and A-1 were sprayed with a power sprayer, while the other two, B and B-1, were sprayed with a traction sprayer. Several times during the summer trouble was experienced with the power sprayer at times when it appeared necessary that applications be made at once. Owing to these difficulties only four applications were made with the power sprayer, and the other three with the traction sprayer. Since this is true no definite conclusions can be drawn from the data at hand.

Table 5 gives the per cent of dead leaves in the different series, with the average for the two methods.

Table 5

Per Cent of Dead Leaves on Plots Sprayed With Traction and With Power Sprayer

Treatment	Per Cent of Dead Leaves					
	Power Sprayer			Traction Sprayer		
	Series A	Series A-1	Average	Series B	Series B-1	Average
4-2-3-50	47	34	40	50	39	44
4-4-3-50	*39	36	37	58	46	52
4-4-50	57	54	55	60	52	56
2-0.4-3-50	56	58	57	56	58	57
0.5-0-3-50	52	60	56	55	44	49

From the table it will be seen that with four of the sprays the use of the power sprayer gave the better control. In one case, that of the 4-4-50 mixture, the difference is only 1 per cent, while it is 15 per cent in the case of the 4-2-3-50 mixture. With the copper-soap mixture the plots sprayed with the traction sprayer showed 7 per cent less dead leaves than those sprayed with the power sprayer. This may be due to the fact that the copper-soap mixture gives best results when applied at a lower pressure than was the case when the power sprayer was used. The data at hand will not warrant any conclusions of this kind, however.

While the differences are by no means great, there seems to be a tendency toward more complete control following the use of the power sprayer. In the use of this machine an effort was made to

spray the under leaf-surface, but only slight success was obtained, so any differences in favor of this machine over the traction sprayer are thought to be due more to the fact that the upper leaf-surfaces received a better covering.

In table 6 is given the total yield per acre of the plots sprayed with the power and traction sprayers, as well as the average for each.

Table 6

Yield Per Acre on the Plots Sprayed with the Traction Sprayer and with the Power Sprayer

Treatment	Yield Per Acre					
	Power Sprayer			Traction Sprayer		
	Series A	Series A-1	Average	Series B	Series B-1	Average
	pounds	pounds	pounds	pounds	pounds	pounds
4-3-3-50	10,761	17,666	14,213	14,160	18,754	16,457
4-4-3-50	12,295	18,016	15,416	13,958	17,256	15,605
4-4-50	13,626	17,379	15,502	16,526	17,072	16,798
3-0.4-3-50	14,416	15,556	14,986	17,771	12,063	14,917
0.5-0-3-50	13,072	17,302	15,187	15,010	16,809	15,909

It will be seen that in every case but one the differences are in favor of the traction sprayer. With Bordeaux mixture this difference is as much as 1296 pounds. A study of the table, however, will show that the normal variation in yield between Series A and Series A-1 and between Series B and Series B-1, is greater than the differences between the averages. The varying factor in this case would appear to be the soil rather than the method of applying the spray. Since this is true no conclusions can be drawn with regard to the relative merits of the two methods.

In view of the fact that the traction sprayer appears to have given as good results as the power sprayer, there is little to warrant the adoption of the latter machine. The cost of upkeep and running the power sprayer is much greater than the traction sprayer, and these factors should favor the use of the latter type of machine.

Summary

1. Late blight of tomatoes caused by *Septoria lycopersici* Speg. can be controlled by thorough spraying.

2. The sprays employed were found to control the late blight in the following order: (1) 4-2-3-50; (2) 4-4-3-50; (3) 0.5-0-3-50; (4) 4-4-50; (5) 2-0.4-3-50.

3. The sprays employed gave increased yields over check plots in the following order: (1) 4-4-50; (2) 0.5-0-3-50; (3) 4-2-3-50; (4) 4-4-3-50; (5) 4-2-3-50.

4. The standard Bordeaux mixture, while not giving the best control, gave the greatest increase over the check plots; indicating, possibly, that failure in its use in the past was a question of methods rather than the fault of the spray mixture.

5. The use of the copper-soap mixture (0.5-0-3-50) gave good results. Because of its low cost and ease of preparation it should be given serious consideration.

6. The Bordeaux-soap mixtures (4-2-3-50 and 4-4-50) gave good control but in other respects they are not as good as the copper-soap mixture.

7. The results of this season's work would indicate that it is not necessary to spray plants in the seed-bed in New Jersey.

8. In this state the first application should be made not later than July 1.

9. From the work conducted this season it would appear that if all the leaves are held until frost a large part of the fruit formed will not ripen.

10. Little difference resulted from the use of the two types of spray machines; the traction sprayer, due to its lower cost of upkeep, would appear to be the better.

Effect of Late Applications

The field in which this experiment was conducted received the same treatment as the first experimental field, with the exception that the plants were set out one week earlier. This land had been in tomatoes for 4 years, and during that time the blight had been very severe.

On July 18 most of the lower leaves of the plants in this field were infected with the blight. It was then decided to spray to de-

termine if the disease could be held in check by a few applications. Only two of the mixtures were used, the 4-4-3-50 and the 0.5-0-3-50, respectively. Since the first application was not made until July 21 their efficiency in controlling the blight was put to a severe test. The sprays were applied with a traction sprayer at 150 pounds pressure, at the rate of 175 gallons to the acre. As in the previous experiment the plants were sprayed once each way for each application.

The plots as laid out were approximately 1/7 acre in size, each plot was 3 rows wide and so arranged that each treated plot was adjacent to an untreated plot. Table 7 gives the arrangement of the plots. In the field they were not divided into two sections, as in the table, but were continuous. Plots 11, and 13 and 15 were sprayed July 21 and 31, while the remaining treated plots received a third application August 11.

Table 7

Arrangement of Plots and Yield per Acre from each Treatment

No.	Treatment	Yield per acre	No.	Treatment	Yield per acre
		pounds			pounds
1	Check	11,848	9	0.5-0-3-50	11,623
2	4-4-3-50	13,391	10	Check	11,275
3	0.5-0-3-50	11,848	11	0.5-0-3-50	11,848
4	Check	9,856	12	Check	12,271
5	4-4-3-50	12,719	13	0.5-0-3-50	13,359
6	0.5-0-3-50	14,909	14	Check	13,391
7	Check	10,952	15	0.5-0-3-50	13,814
8	4-4-3-50	11,176	16	Check	11,410

On August 24 a thorough examination was made of these plots. The plots sprayed three times were almost free from any infection, while the check plots were heavily infected, nearly every leaf showing spots. On the plot sprayed twice there was considerable infection, but these plots were decidedly better than their adjoining checks.

On September 5 another observation was made. At this time the plots sprayed twice were little better than their adjoining checks. This is to be expected since the last application of spray had been made July 31 and had without doubt been washed from the plants long before this, leaving them unprotected. The plots

sprayed three times were still better than the adjoining checks. The leaves were all diseased but were still green, while on the unsprayed plants only a few leaves remained at the apex of the branches.

In table 8 is given the average yield per acre for the plots receiving the two applications of spray as well as for their adjoining checks.

Table 8

Effect of Two Applications of Spray

Treatment	Pounds per acre	Difference
0.5-0-3-50	13,007	920
Check	12,087	....

Two applications of the copper-soap mixture gave an increase of 920 pounds over the adjoining checks. It is true that there is a large normal variation between the check plots, but inasmuch as the treatment and its check were repeated three times, the differences resulting from the averages may be attributed in part to the varying factor, which in this case is the two applications of spray.

In table 9 is given the average yield of the plots sprayed three times with that of their adjoining checks.

Table 9

Effect of Three Applications of Spray

Treatment	Pounds per acre	Difference
4-4-3-50	12,428	1,543
Check	10,885	....
0.5-0-3-50	12,800	2,106
Check	10,694	....

As in the first experiment the plots sprayed with the copper-soap mixture gave a greater increase over the checks than did the Bordeaux-soap mixture, being 19 per cent and 14 per cent, respectively. While the Bordeaux-soap gave slightly better control in the first experiment, in this one little difference was observed between the two treatments.

The results of this experiment would tend to show that late blight can be held in check after it appears in a field and also would indicate that early applications are not essential. The necessity of late applications is shown conclusively. The plots sprayed twice were killed some time before those sprayed three times. There is no reason to doubt that, had a fourth application been made, the plants would have remained green for several weeks longer.

The results of this and the first experiment indicate beyond a doubt, that late blight of tomatoes can be controlled by spraying, but the results also emphasize the importance of spraying at the right time. From our present knowledge, in order that the grower may be sure of spraying at the proper time, the applications should be spread over a long period of time; in other words, the vines should be kept covered. Where this is done success should follow.

Summary

The results of the above experiment may be summarized as follows:

1. The copper-soap and Bordeaux-soap mixtures will hold late blight in check even after it has appeared in the field.

2. The copper-soap mixtures appeared to control the blight as well as the Bordeaux-soap mixture.

3. The plots sprayed with the copper-soap mixture showed the largest increase over the unsprayed plots.

4. Early applications do not appear to be essential in the control of the late blight.

5. Two applications held the disease in check, while the third gave much better results, indicating that the late applications are of great importance.

6. The results emphasize the importance of spraying at the proper time, a few applications made indiscriminately cannot be expected to give results.

Effect of Spraying Late Tomatoes

This experiment was designed to determine the effect spraying would have upon late tomatoes. The soil in this field is much heavier than that in the other two. No manure has been applied to this land for the past four years; before the plants were set out 600

pounds to the acre of the following mixture was added: 1400 pounds of phosphoric acid, 200 pounds of nitrate of soda and 400 pounds of tankage.

The plots were laid out as in the preceding experiment and the following spray mixtures were used; 4-2-3-50; 0.5-0-3-50; 2-0.4-3-50; and 0-0-3-50. The latter was made up of resin fish-oil soap at the rate of 3 pounds to 50 gallons of water. This was used to determine if the soap had any fungicidal value when used alone. Applications were made on the following dates: July 31, August 13, August 19, August 28, September 3 and September 11, making 6 applications in all.

In table 10 is given the arrangement of the plots together with the yield in ripe and green fruit, as well as the total yield per acre.

Table 10

Arrangement of Plots and Yield Per Acre

Treatment	Ripe fruit per acre	Green fruit per acre	Total yield
	pounds	pounds	pounds
Check	10,955	2,112	13,067
4-2-3-50	11,203	4,225	15,428
0.5-0-3-50	9,648	3,703	13,351
Check	9,365	2,896	12,261
0-0-3-50	8,581	3,158	11,739
2-0.4-3-50	8,712	5,009	13,721
Check	7,252	2,635	9,887
4-2-3-50	8,538	5,009	13,547
0.5-0-3-50	8,276	3,158	11,434
Check	10,019	2,374	12,393
0-0-3-50	10,589	2,896	13,485
2-0.4-3-50	10,628	3,419	14,047
Check	10,345	1,847	12,192
4-2-3-5	11,086	3,158	14,244
0.5-0-3-50	10,409	2,374	12,784
Check	11,874	1,187	13,061
0-0-3-50	11,042	1,847	12,889
2-0.4-3-50	10,498	1,847	12,345
Check	10,606	1,317	11,923

Late blight did not appear in this field until September 5, and in the week following it became more prevalent though it never became very severe. This appeared to be true on all the fields; after the first week of September the disease made very little progress. On October 21 careful observations were made to determine the per cent of dead leaves in each plot, following the plan outlined in the first experiment.

Table 11 gives the per cent of dead leaves for each plot, as well as the average for each treatment.

At the time of this observation the unsprayed plants were still in fairly good condition. The leaves remaining on the plants showed very little infection and were of a good green color.

Table 11

Per Cent of Dead Leaves in Each Plot and Average for Each Treatment

Treatment	Series 1	Series 2	Series 3	Average
4-2-3-50	38	41	53	42
0.5-0-3-50	40	53	61	51
2-0.4-3-50	45	62	57	64
0-0-3-50	59	62	64	62
Check	67	73	85	75

The plots sprayed with the 4-2-3-50 mixture were slightly better than those sprayed with the copper-soap; the difference was not marked, however. The plots treated with the soap solution were better than the untreated, as there were 13 per cent less dead leaves on the former than on the latter. This would indicate that the soap alone had some fungicidal value.

Table 12

Ripe and Green Fruit and Total Yields Per Acre Average of Three Plots

Treatment	Ripe fruit per acre	Green fruit per acre	Total yield	Difference
	pounds	pounds	pounds	pounds
Check	9,517	2,198	11,715	....
4-2-3-50	10,275	4,130	14,405	2,690
0.5-0-3-50	9,445	3,078	12,523	19
Check	10,352	2,152	12,504	....
0-0-3-50	10,054	2,634	12,688	184
2-0.4-3-50	9,946	3,425	13,371	2,027
Check	9,401	1,933	11,334	....

Table 12 gives the average yields of the different treatments and of their adjoining checks.

The data in table 11 would indicate that the Pickering mixture has given as good results as the Bordeaux-soap mixture. Both of

these treatments gave an increase of 1 ton to the acre over their adjoining checks. The copper-soap mixture and the soap solution gave slight increases, but these are well within the experimental error, and no indicative results can be attributed to these two sprays. These slight differences may be explained by the fact that there was comparatively little disease in this field. Why two of the mixtures should give increased yields and the other two no increase, is rather difficult to explain in the light of the results of the first two experiments where the copper-soap mixture out-yielded the Bordeaux-soap mixtures.

The results secured would indicate that in this particular case it did not pay to spray. This variety of tomato is very late in ripening its fruit and where the the greater part of the leaves have been held until frost the ripening process is still further delayed. In this experiment the average amount of green fruit picked from the sprayed plots was 85 per cent more than from the unsprayed plots. However, no statement to the effect that it does not pay to spray late tomatoes can be made. In a field adjoining this, when the tomatoes were of the same variety but the plants were set out a week earlier, the plants were killed early in the season. In this case there is no doubt that spraying would have paid. Just why this difference should exist in the amount of disease present in the two fields is difficult to state. The field in which the experiment was conducted was high and well drained, while the other was low and comparatively wet, so there may be some relation between soil moisture content and appearance of the disease. Several other instances were noted during the summer where the disease first made its appearance in the lower portions of a field.

The results of this experiment would tend to indicate the impossibility of making any fixed dates for spraying The appearance of the disease seems to be largely determined by local conditions and results will be secured only through the efforts of the individual grower to make applications at the proper time.

Summary

1. In this experiment the different spray mixtures controlled the blight in the following order: (1) 4-2-3-50; (2) 0.5-0-3-50; (3) 0.4-3-50; (4) 0-1-3-50.

2. Resin fish-oil soap gave partial control, indicating that it possesses some fungicidal value when used alone.

3. The results obtained from the experiment emphasize the fact that conclusions cannot be drawn from the results of one season's work.

4. Under certain conditions, in view of the results from this experiment, the advisability of spraying late tomatoes is questionable.

POTATO SPRAYING EXPERIMENTS IN 1917

MEL. T. COOK

During 1917 the department conducted potato spraying experiments in cooperation with Mr. T. M. Applegate, of Dayton, N. J. and with Mr. J. Harry Kandle of Elmer, N. J.

The work with Mr. Applegate was in cooperation with Mr. I. L. Owen, farm demonstrator for Middlesex County. In both cases the actual work was done by the growers according to plans furnished by the writer. The Kil-Tone and arsenate of lead were furnished by the Kil-Tone Manufacturing Company.

The test on Mr. Applegate's farm was made on early Cobblers. He sprayed this crop three times, using a combination of Bordeaux and arsenate of lead on 6 plots and arsenate of lead on the alternating 6 plots. The plots were 0.116 acre in size. The results when reduced to an acre basis are given in table 14.

Table 14

Yield of Potatoes Per Acre on Test Plots on Farm of T. M. Applegate, Dayton, N. J.

Treatment	Bushels per Acre
Bordeaux and lead	183.475
Arsenate of lead	168.535
Bordeaux and Lead	153.780
Arsenate of lead	173.560
Bordeaux and lead	178.445
Arsenate of lead	183.475
Bordeaux and lead	203.535
Arsenate of lead	208.189
Bordeaux and lead	183.475
Arsenate of lead	168.535
Bordeaux and lead	168.585
Arsenate of lead	148.705

It will be noted that the highest yield was 208 bushels on the arsenate of lead plot, and that the lowest yield was 148 bushels, also on an arsenate of lead plot. The average yield of the Bordeaux and lead plots was 178.532 bushels, as compared with an average yield of 175.166 bushels on the arsenate of lead plots, a difference of less than 3½ bushels per acre.

Two tests were made on Mr. Kandle's farm, one with a crop of early Cobblers and the other with a crop of late Cobblers (i. e. second-crop). The early Cobblers were sprayed twice, using Bordeaux and lead, Kil-Tone, and arsenate of lead. The plots were 3/10 acre in size and the results reduced to an acre basis are given in table 15.

Table 15

Yield of Early Cobblers Per Acre on Test Plots on Farm of J. Harry Kandle, Elmer, N. J.

Treatment	Bushels per Acre
Bordeaux and lead	300.000
Kil-Tone	316.662
Arsenate of lead	297.912
Bordeaux and lead	289.062
Kil-Tone	328.125
Arsenate of lead	323.125
Bordeaux and lead	314.582
Kil-Tone	306.250
Arsenate of lead	311.458
Bordeaux and lead	316,666
Kil-Tone	320.833
Arsenate of lead	317.083
Bordeaux and lead	325.000
Kil-Tone	309.375
Arsenate of lead	317.083

An examination of the results of this test shows the highest yield was 328 bushels on a Kil-Tone plot, and that the lowest yield was 289 bushels on a Bordeaux and lead plot. The average, in order of highest yield, was Kil-Tone 316.249 bushels; arsenate of lead 313.332 bushels and Bordeaux and arsenate of lead 309.062 bushels.

The late crop of Cobblers was sprayed twice with Bordeaux plus arsenate of lead and with Kil-Tone. As there were not enough potato bugs to injure the crop, it was decided to leave 4 plots with-

out treatment of any kind. The plots were one-third of an acre in size[2] and the results reduced to an acre basis are given in table 16.

These results show that the highest yield was 249 bushels on a Kil-Tone plot, and that the lowest yield was 195 bushels on an *untreated* plot. The average, in order of highest yield, was Kil-Tone 224.062 bushels, Bordeaux and lead 217.500 bushels, and untreated 210.469 bushels.

I doubt if much weight should be attached to these figures. In the early part of the season the potato crop was exceptionally free from diseases and the growth unsually good. In July heavy rains and warm weather brought on a most severe outbreak of tip burn followed by a severe outbreak of early blight. The exceptionally healthy condition of the crop in the early part of the season would necessarily result in slight differences in treatments; the luxuriant growth interfered with the treatments, the July rains washed the spray mixtures off and the tip burn stopped further treatment.

Table 16

Yield of Late Cobblers Per Acre on Test Plots on Farm of J. Harry Kandle, Elmer, N. J.

Treatment	*Bushels* per Acre
Bordeaux and lead	204.375
Kil-Tone	349.375
Untreated	215.625
Bordeaux and lead	215.625
Kil-Tone	221.250
Untreated	210.000
Bordeaux and lead	225.000
Kil-Tone	215.625
Untreated	221.250
Bordeaux and lead	225.000
Kil-Tone	210.000
Untreated	195.000

[2]The plots were just twice as large as indicated, but only the central half of each plot was used in tabulating the results.

Aerial form of crown gall on branches of the apple.
(Photo by C. H. Connors.)

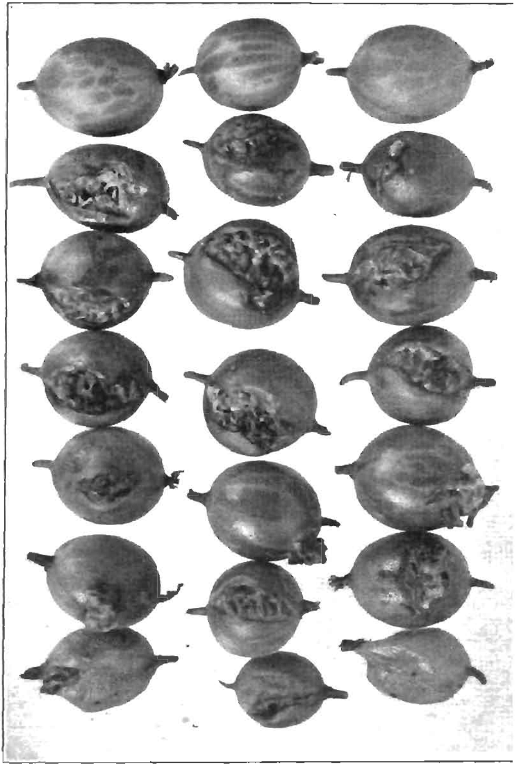
PLATE II

Greenhouse chrysanthemum attacked by common dodder.
(Photo by R. F. Poole.)

PLATE III

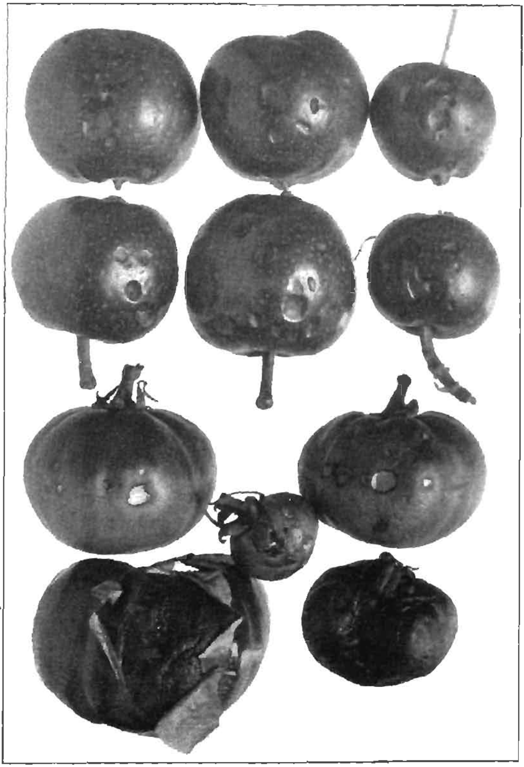
Poplar Canker (Dothichiza populæ).
(Photo by R. F. Poole.)

PLATE IV



Hail-stone injury on gooseberries.
(Photo by R. F. Poole.)

PLATE I



Hail-stone injuries on tomatoes and apples.
(Photo by R. F. Poole.)

PLATE VI

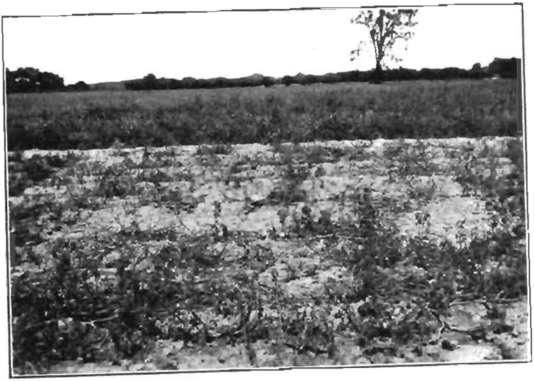


FIG. 1. Tomato spraying experiment: Plot 18 (Check).

FIG. 2. Tomato spraying experiment: Plot 19 (4-2-3-50).